Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | NOVEMBER, 1946 | PITTSBURGH, PENNSYLVANIA

HNOLOGY DEPT.

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DETROIT

TO-DAY

hese two illustrations afford a good comparison — as far as appearance is concerned — between the Timken Balanced roportion Bearing and the Timken Bearing that preceded it.

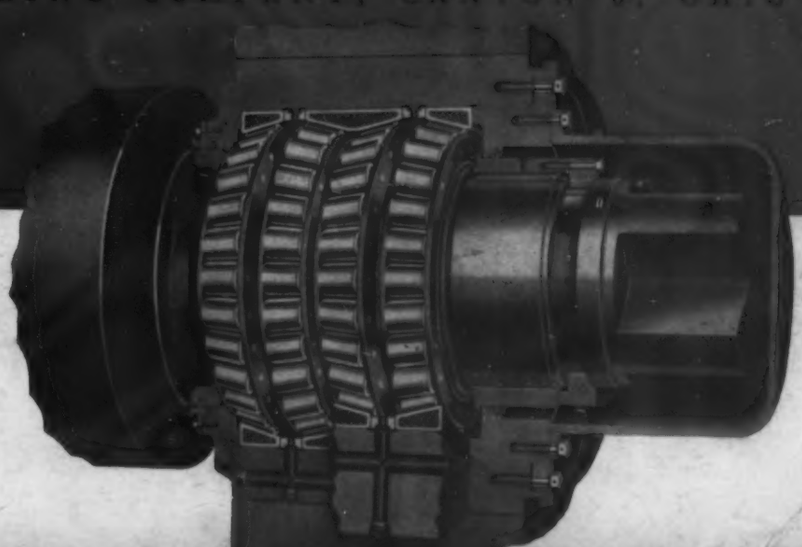
or this contrast we selected 4-row bearings of the same outside diameter; but there the similarity ends.

he principal features of Balanced Proportion design — the features that have revolutionized rolling mill bearing perform- nce — are plainly discernible in the upper picture.

here you can see the great number of longer rolls, the larger bore, the increased overall width that so greatly increase the earing's separating force capacity while decreasing roll neck stress and deflection to a corresponding degree.

esterday's Timken Roll Neck Bearing still is a good bearing — second only to the Timken Balanced Proportion Bearing performance, endurance and economy. It will continue to give a good account of itself wherever now installed.

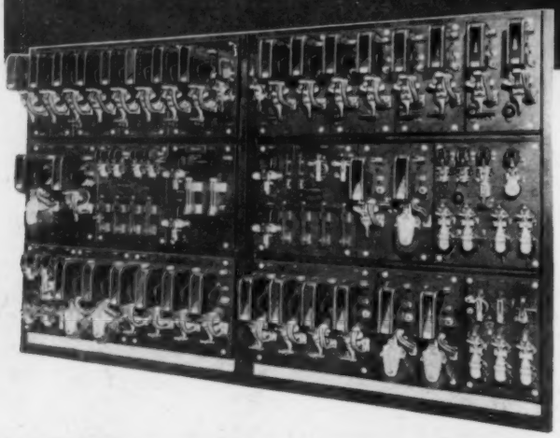
HE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO



YESTERDAY

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.

When you have a two or four motor bridge drive on a crane or ore bridge . .



. . That calls for

Cutler-Hammer No. 14145 (Wilson-Ritchie) D. C. reversing Dynamic Braking Control

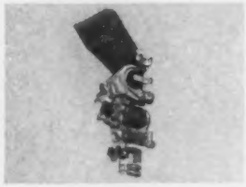
In addition to the unique Cutler-Hammer *Ltl* Inductive Time Limit method of acceleration, Cutler-Hammer Bulletin No. 14145 also employs the Wilson - Ritchie scheme in case of power failure for emergency dynamic braking on series wound motors.

This safety feature is gained by cross-connecting series fields and motor armatures to provide the correct polarity for dynamic braking by self-excitation. The feature may be used both for emergency stops and service stops. The contactors used are C-H standard, affording the ruggedness and simplicity that make Cutler-Hammer Mill Control outstanding.

NOTE: As shown at left, Cutler-Hammer also makes available emergency dynamic braking for single motor applications as well. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. Associate: Canadian Cutler-Hammer, Ltd., Toronto.

CUTLER·HAMMER
MOTOR CONTROL
C-H

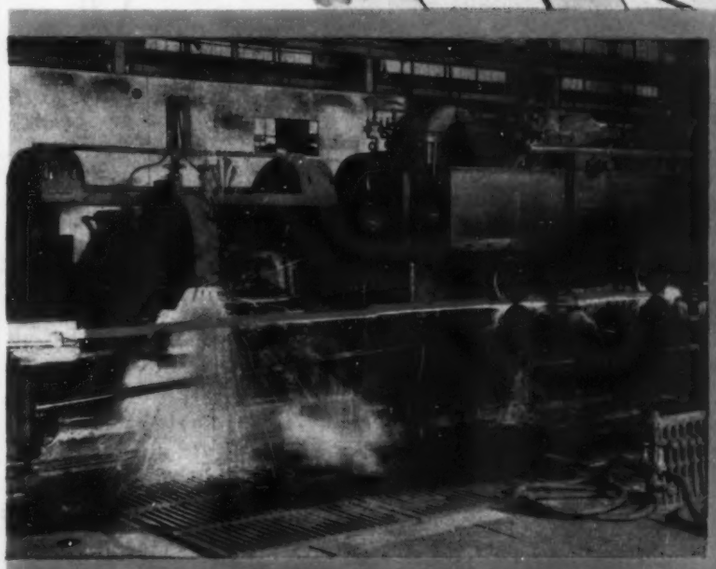
Typical Components of Cutler-Hammer Mill Control

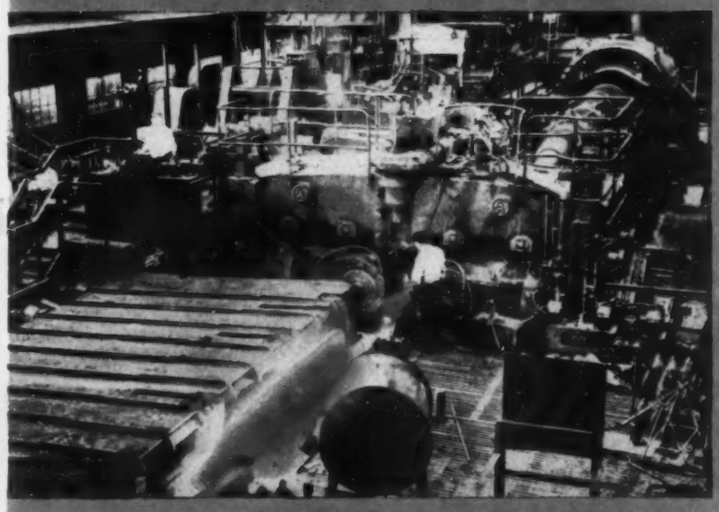


Mill-type contactors whose reliability, life and low maintenance have made them the standard for industry.

Space Heaters provide easily installed, comfortable heat for operators in crane cabs, etc.

Emergency dynamic braking panel for single motor crane installations.





In mill machinery, Aetna-Standard ranks at the top in several classifications:

- Seamless Tube Mills
- Continuous Butt Weld Pipe Mills
- Coating Equipment, Continuous Galvanizing and Tinning
- Drawbenches
- Mill Tables and Cooling Beds
- Flat Rolled Finishing Equipment

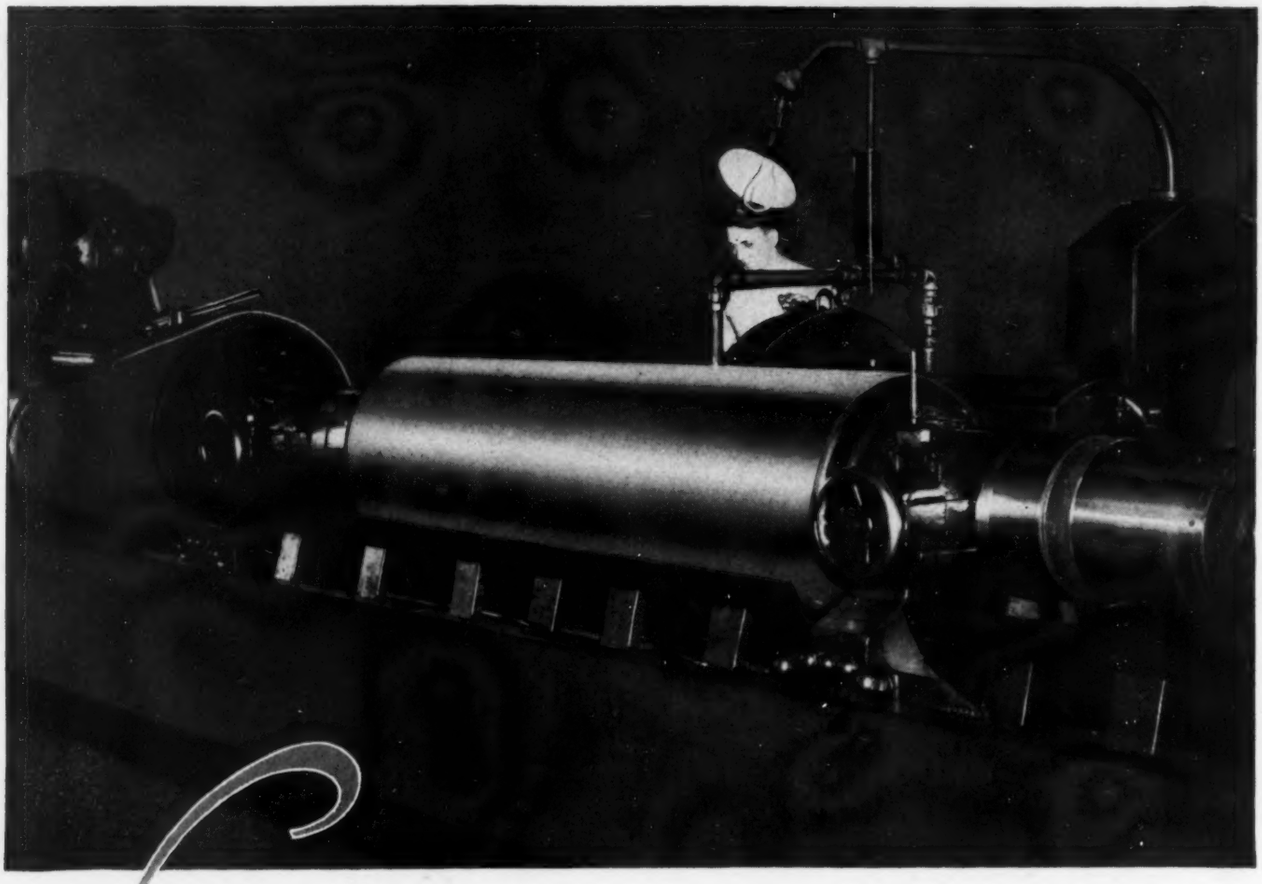
Converting ideas into productive production, that is, making machinery to efficiently produce, form, and process steel, brass, copper, or aluminum, is our business.

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries

THE AETNA-STANDARD ENGINEERING CO.—YOUNGSTOWN, OHIO

Associated Company: HEAD, WRIGHTSON & COMPANY, LIMITED · MIDDLESBROUGH, ENGLAND

Aetna-Standard



Craftsmen

IN HEAVY METAL

The business of making sound, long wearing iron and alloy iron rolls is an exacting task. The National organization through years of experience, has developed this knack to the highest degree. Constant metallurgical laboratory control keeps check on all foundry operations. Modern machine tools in the hands of experienced workmen expedite this phase of production — assure precision finishing to roll surfaces. Whatever may be your requirements for cast iron rolls, National is staffed and equipped to accurately and speedily produce them.

NATIONAL ROLLS
TRADE MARK REG.

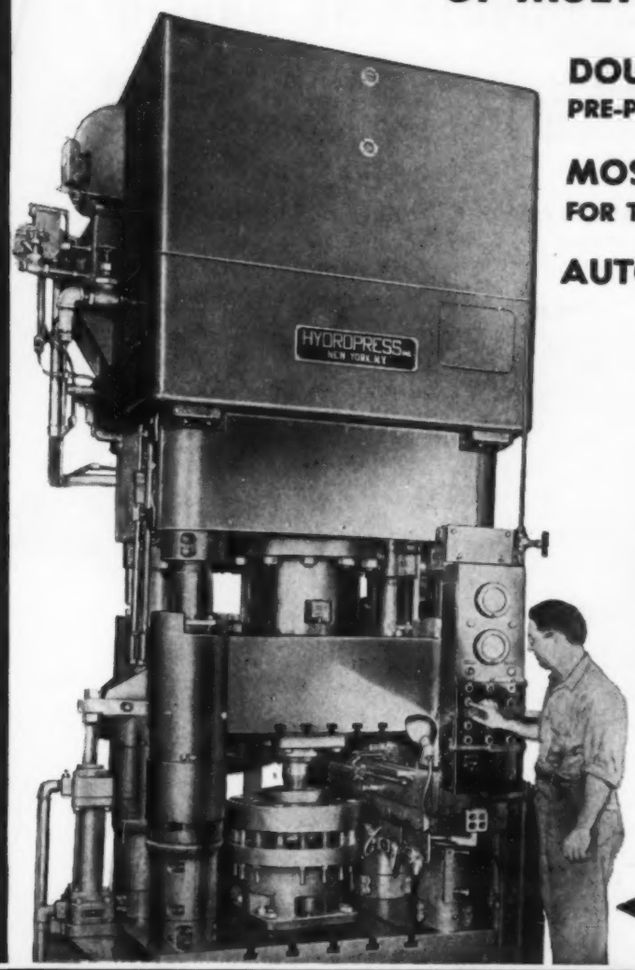
National Rolls

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

Manufacturing IRON AND ALLOY IRON ROLLS *Exclusively*

HYDRAULIC PRESSES
FOR POWDER METALLURGY

AUTOMATIC FULL-HYDRAULIC SINGLE ACTION PRESSES HAVING THE ADVANTAGES OF MULTIPLE FUNCTION MACHINES



DOUBLE PURPOSE FOR
PRE-PRESSING AND COINING OPERATIONS

MOST ACCURATE ADJUSTMENTS
FOR TONNAGE, POWDER FLOW, PRESSING SPEED

AUTOMATIC ELECTRONIC CONTROLS

OUR PRESSES ARE CUSTOM-BUILT TO THE SPECIFIC PRODUCTION REQUIREMENTS OF EACH CUSTOMER

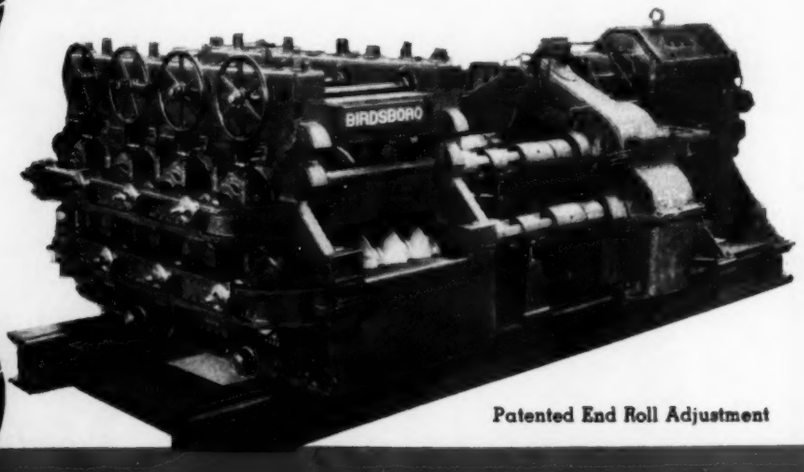
LET US KNOW YOUR SPECIFICATIONS
OUR STAFF OF ENGINEERS
WILL BE GLAD
TO HELP YOU
WITH YOUR PLANNING

500 TON SELF-CONTAINED OIL-HYDRAULIC
PRE-PRESSING AND COINING PRESS FOR POWDERED METAL
AT THE AMERICAN ELECTRO METAL CORP., YONKERS, N.Y.

HYDROPRESS · INC.
ENGINEERS CONTRACTORS
HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES
566-568 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

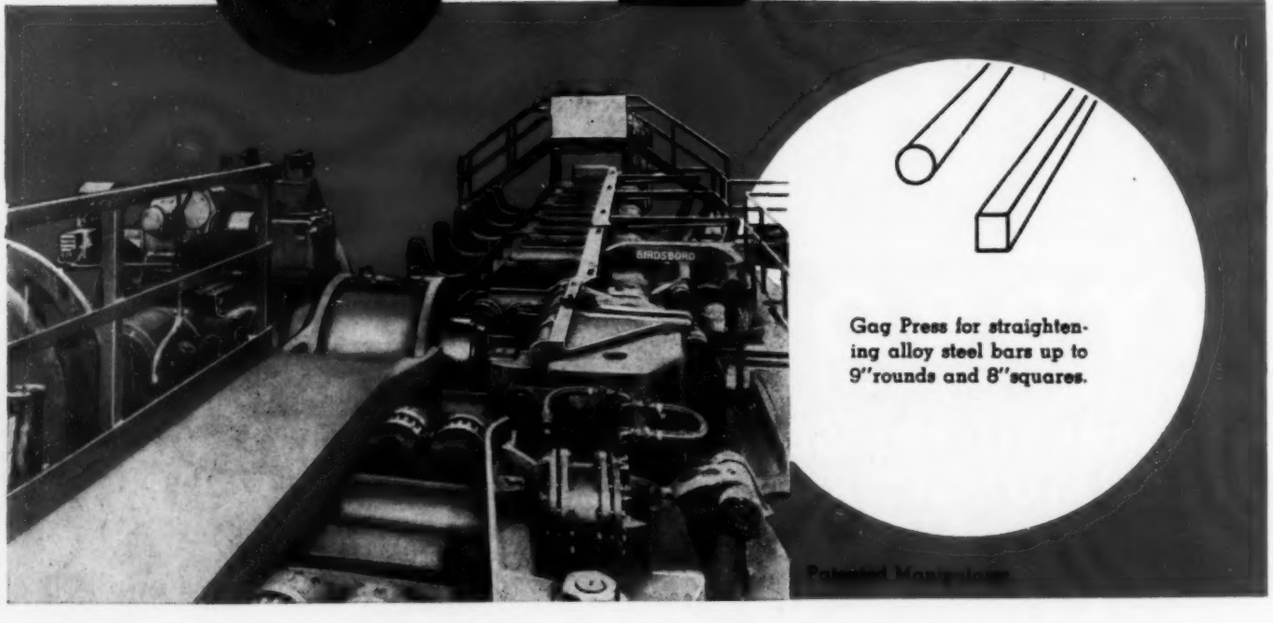
FASTER, MORE ACCURATE
Straightening
ON ANY OF THESE
BIRDSBORO
STRAIGHTENING MACHINES

Rail Straightening Press having capacity for straightening 150 lb. rails.

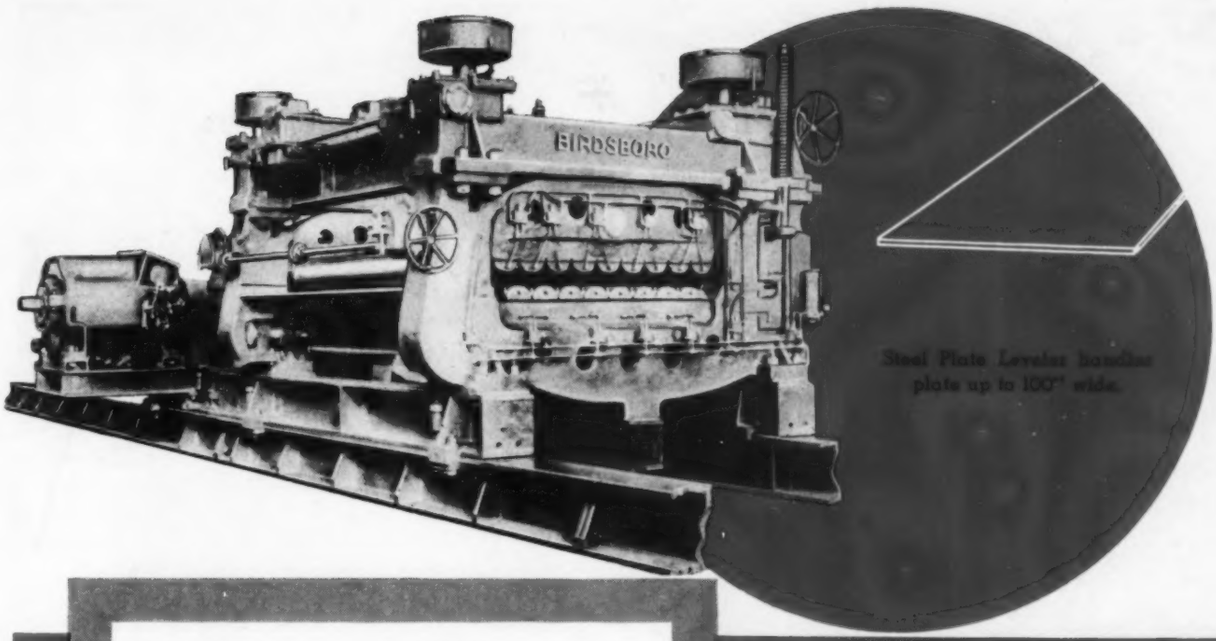


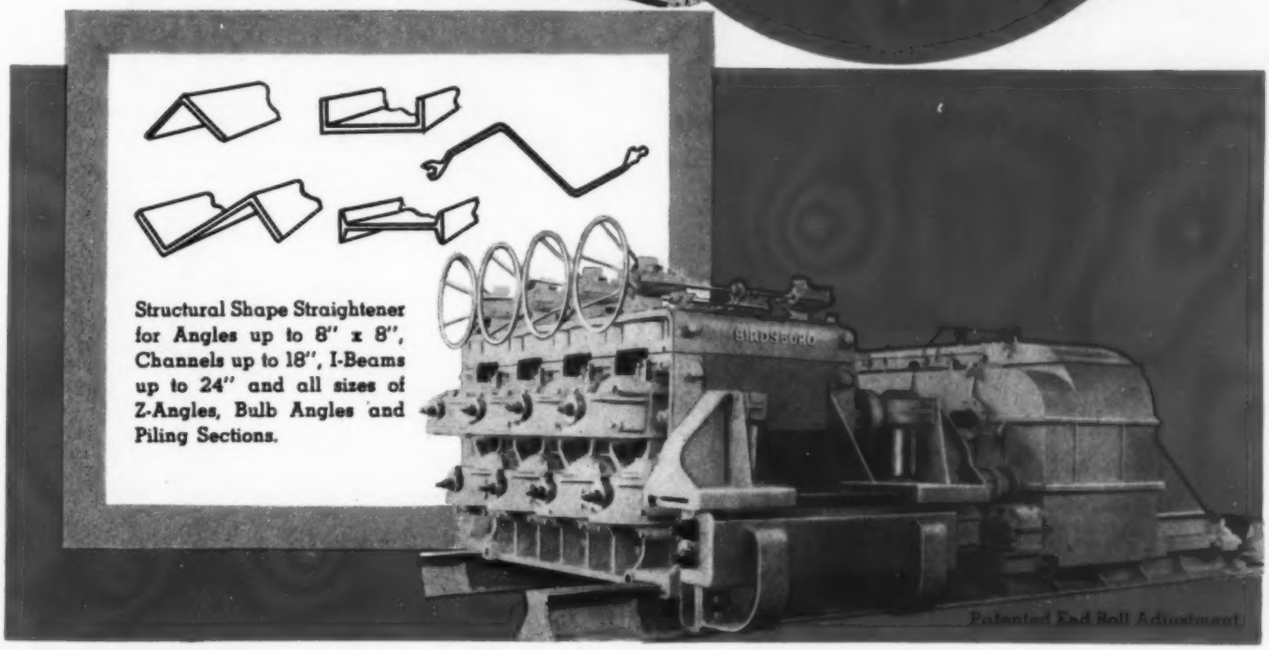
Structural Shape Straightening Machine with capacity up to 6" x 6" angles.

Patented End Roll Adjustment



Gag Press for straightening alloy steel bars up to 9"rounds and 8"squares.




Structural Shape Straightener for Angles up to 8" x 8", Channels up to 18", I-Beams up to 24" and all sizes of Z-Angles, Bulb Angles and Piling Sections.
BIRDSBORO
Patented End Roll Adjustment

These five versatile Birdsboro Machines meet the major straightening needs of heavy industry. They have been designed for easy, trouble-free operation and built for rugged service . . . with recently developed features that reduce production costs.

When your problem involves the straightening of any metal shapes in large or small sizes, investigate Birdsboro's facilities for producing machinery to meet your specific requirements. Our designers and engineers will welcome the opportunity to work with you to arrive at a practical solution to your problem. Get in touch with us today.

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA
Manufacturers of Steel Mill Equipment, Iron and Steel Rolls, Hydraulic Presses, Crushing Machinery, and Special Machinery

BIRDSBORO
STEEL MILL EQUIPMENT

a New

UNITED

250 TON PERFORATING PRESS

- Compact, All-Steel Construction
- Centralized Lubrication
- Easily Accessible for Die Changing

This 250 Ton Mechanical Sheet Perforating Press is arranged to punch out a wide variety of perforations one-eighth of an inch to one and one-half inches in diameter in sheets up to 55 inches in width, and also special shape and grill-work punching, the number of holes of a given size being proportional to the thickness and physical characteristics of the material to be perforated.

The punch is motor crank operated through entirely enclosed drive with D.C. Ward-Leonard control to give speeds of 30 to 120 strokes per minute. The motor is provided with a start and stop single stroke, continuous running and inching control for adjustment of the punches and dies.

Material is fed into and out of the press by pinch rolls, located on the entry and delivery sides, actuated by an inching clutch and variable stroke crank to give a variable feeding stroke of 0" to 3". Feeding mechanism is mechanically synchronized with the operation of the punch.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q., Canada

★ *The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

BILLETEER LABOR SAVINGS REALLY COUNT NOW

Recent wage increases make it necessary to scrutinize operations all down the line to avoid being squeezed between fixed price ceilings and rising costs.

Here is where Billeteer-equipped billet-sheds have the edge on mills which still rely on manual methods of steel conditioning.

One man operating a Bonnot Billeteer does the work of ten hand chippers, saving $1.66½ (9 × 18½c) an hour *just in wage increases.*

So this is *but a fraction of the total savings* which the Billeteer is making in scores of mills. It never gets tired, groggy or jittery . . . works with unflagging efficiency through shift after shift, doing a neater and better job and releasing good men for less killing tasks.

With a semi-skilled operator, the Bonnot Billeteer easily cleans billets that would be scrapped because of the prohibitive cost of manual chipping. And it enables you to salvage tons of clean, known-analysis chips, ready for immediate resmelting.

Let us show you how the Billeteer can help to cut your steel conditioning costs. Write for the facts and figures.

Bonnot also engineers and builds other modern cost-saving equipment for the iron and steel industry. Send for details today.

CHARGING TABLES • BILLET INSPECTION TABLES • CLAY MIXERS • GRINDING PANS CLAY FEEDERS • COLD SAWS

Engineered for Profitable Production

Bonnot

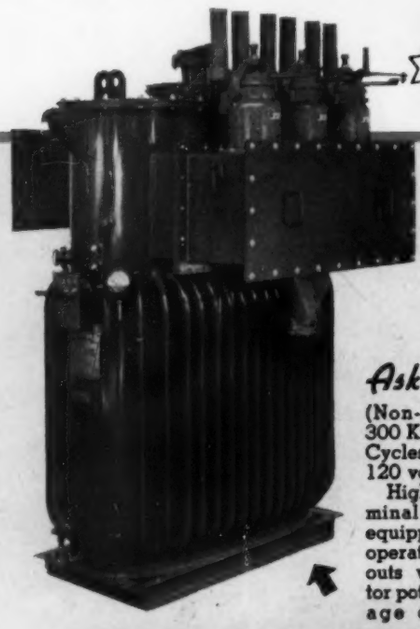
THE BONNOT COMPANY

BUILDERS OF THE BILLETEER

CANTON 2, OHIO

ADDRESS CORRESPONDENCE TO STEEL EQUIPMENT DIVISION

Whether it's for INDOOR *or* OUTDOOR UNIT SUBSTATIONS *Specify* PENNSYLVANIA TRANSFORMERS



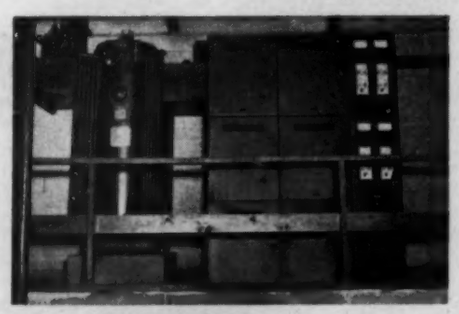
Pennsylvania TRANSFORMERS

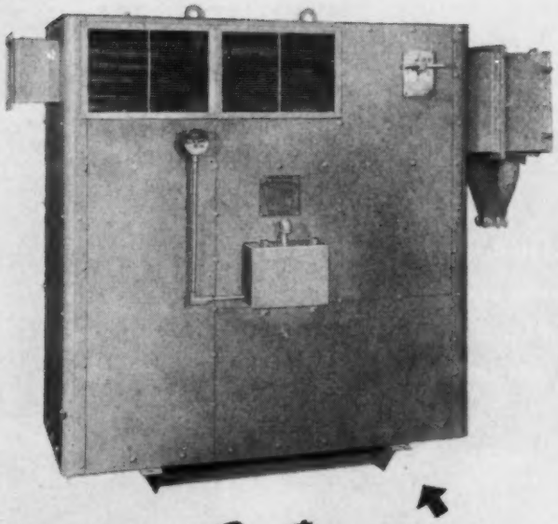
Pennsylvania Unit Substation Transformers combine with Switchgear made by recognized manufacturers to form complete Unit-Substations. Designs are coordinated and the successful operation of all components is guaranteed.

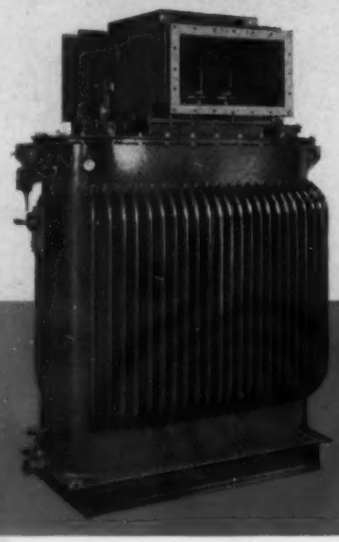
THUS YOU SELECT THE MAKE OF SWITCHGEAR YOU WANT, A PENNSYLVANIA TRANSFORMER TO GO WITH IT; AND GET THE BEST COMBINATION OF THE FINEST UNIT-SUBSTATION EQUIPMENT.

Askarel
(Non-Inflammable)
300 Kva, 3 Phase, 60 Cycles, 2400 - 208/120 volts.

High voltage terminal compartment equipped with gang operated oil-fuse cutouts with 3-conductor pothead. Low Voltage compartment.







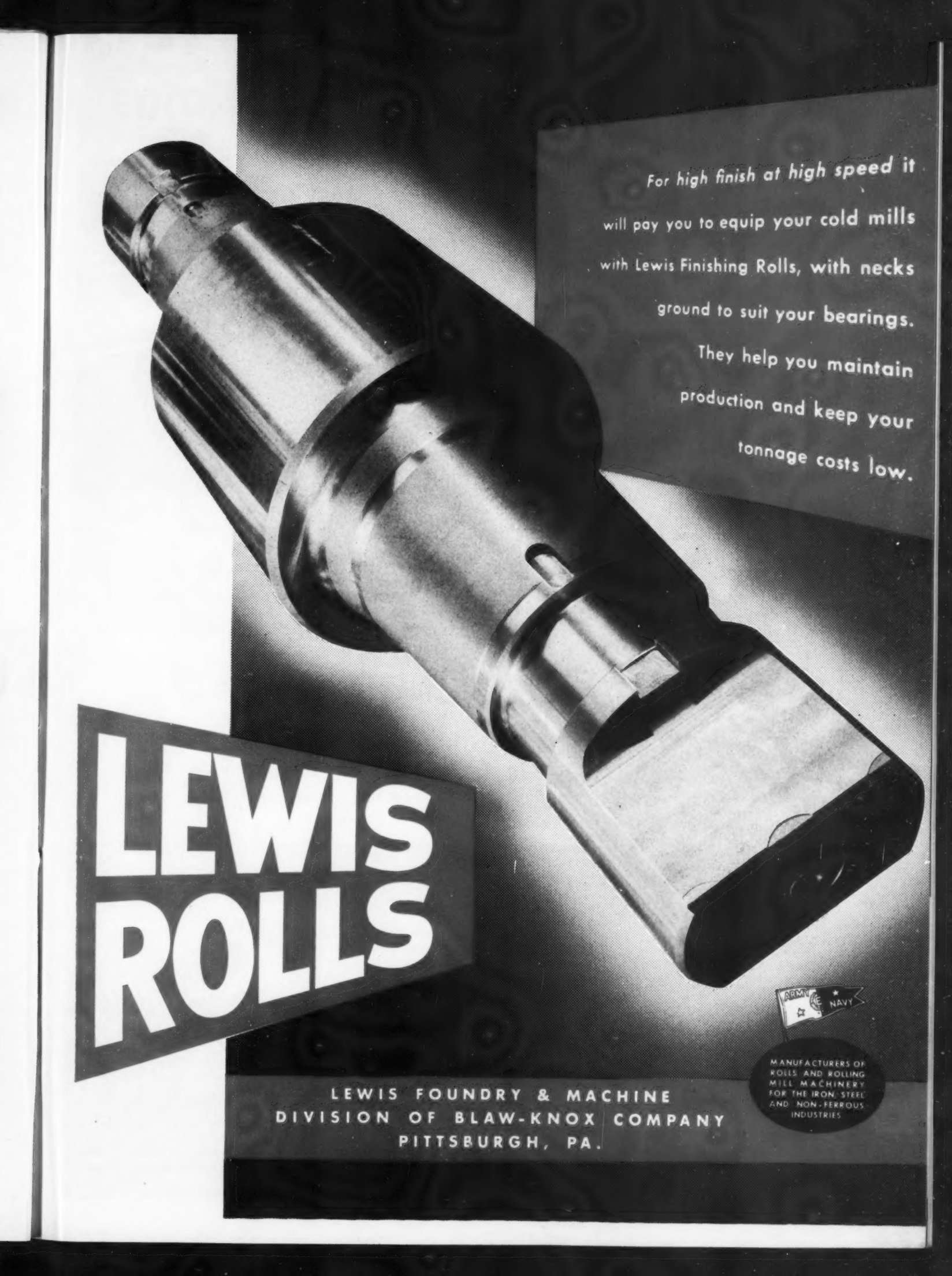
Oil Type OIL-FILLED-
500 Kva, 3 Phase, 60 Cycles, 2400 - 480 volts.

High voltage leads issue into compartment provided with pothead. Low voltage bushings issue into throat for connection to switchgear.

Dry Type - 1000 Kva, 3 Phase, 60 Cycles, 12000-480 volts.

High voltage leads issue into throat connected to Detachable Pothead Compartment. Low voltage throat for connection to switchgear.

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVENUE, PITTSBURGH 12, PENNSYLVANIA


For high finish at high speed it
will pay you to equip your cold mills
with Lewis Finishing Rolls, with necks
ground to suit your bearings.
They help you maintain
production and keep your
tonnage costs low.
LEWIS
ROLLS
ARMY
NAVY
MANUFACTURERS OF
ROLLS AND ROLLING
MILL MACHINERY
FOR THE IRON, STEEL
AND NON-FERROUS
INDUSTRIES
LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX COMPANY
PITTSBURGH, PA.

Mesta 28" Heavy Duty Roll Grinder, Traveling Table Type

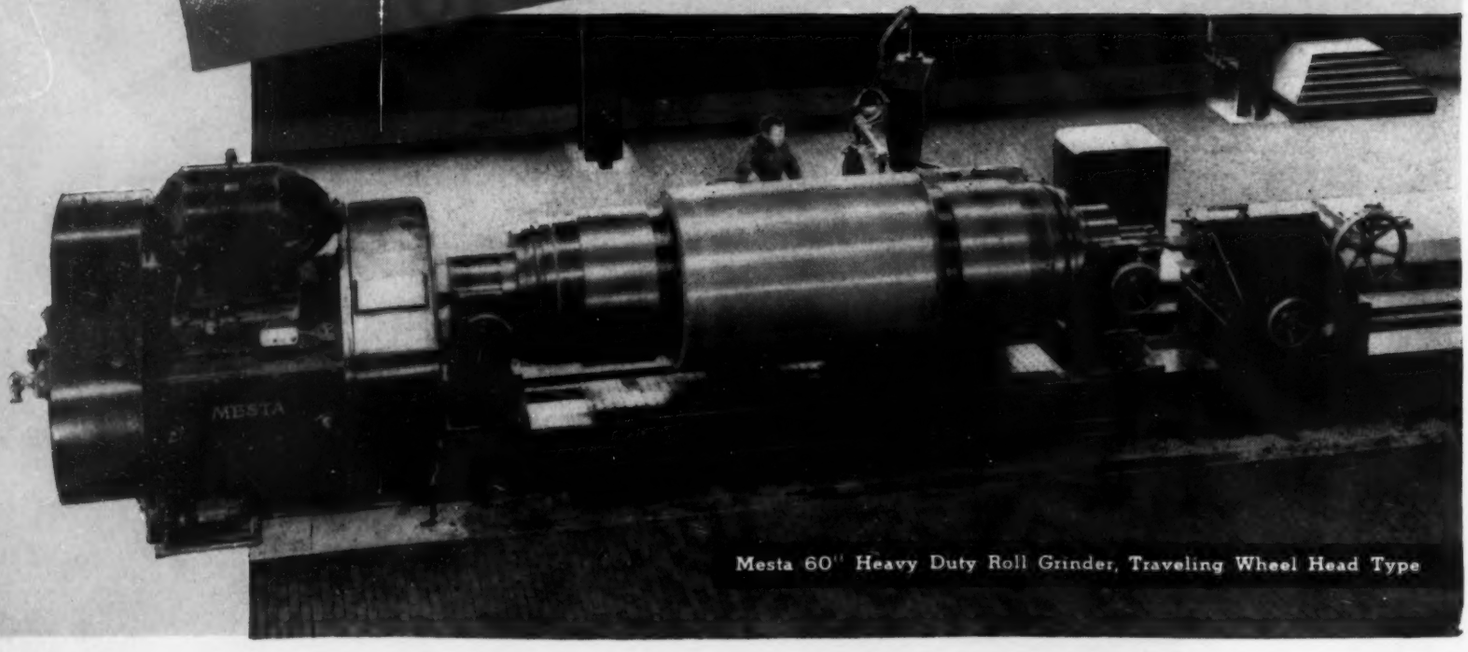
MESTA *Roll Grinders*

MESTA Roll Grinders of simplified design are the most accurate and dependable grinding machines available today. Built with precision for the finest finishing and with ruggedness for the heaviest roughing.

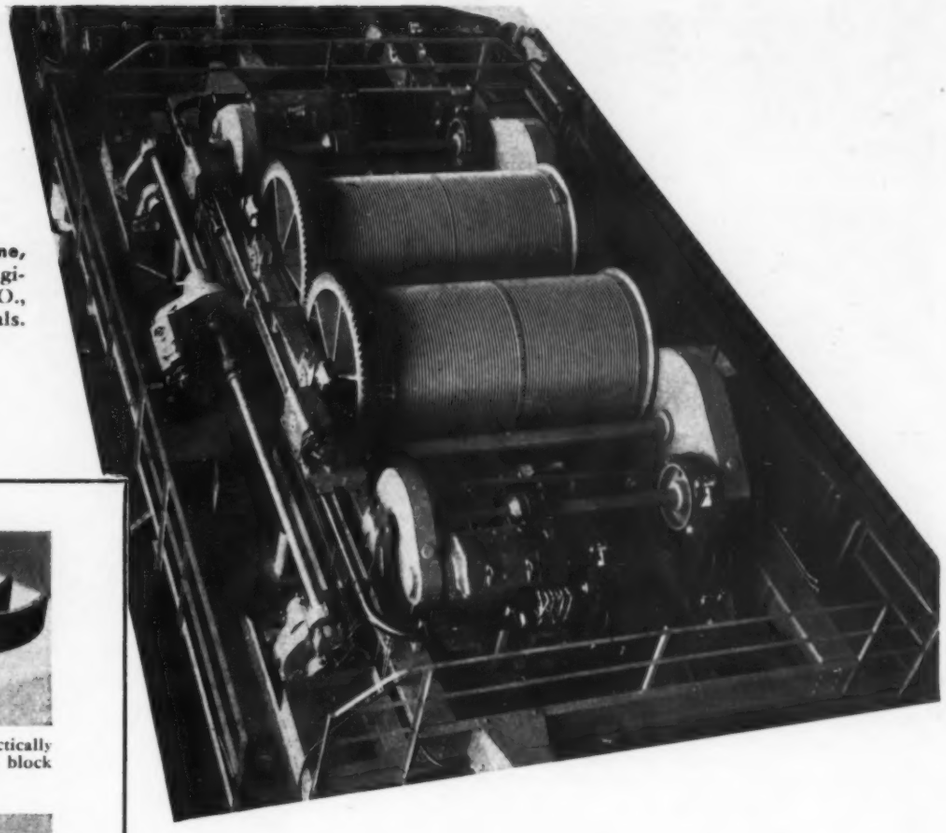
MESTA MACHINE CO.

PITTSBURGH, PA.

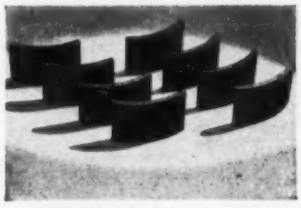
World's Leading Designers and Builders of Complete Steel Plants



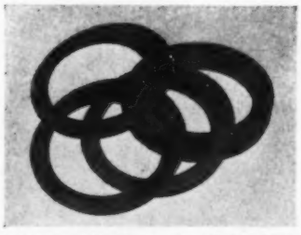
Mesta 60" Heavy Duty Roll Grinder, Traveling Wheel Head Type



260-Metric Ton Ladle Crane, built by the Morgan Engineering Co. of Alliance, O., uses J-M Friction Materials.



J-M Friction Blocks . . . for practically all conditions where a rigid block material is required.



J-M Clutch Facings . . . Available in a wide variety of materials for cone and disc clutches.

J-M Folded and Compressed Ground Lining . . . the standard general utility lining; semi-flexible; long wearing.

J-M Molded Friction Lining . . .Industry's Number One Molded Lining for long economical service.

J-M Friction Materials say:

"STOP and GO"

on this 260-Metric Ton Ladle Crane

When this powerful ladle crane operates it will lift and lower tons of weight *safely*—because it is equipped with Johns-Manville Friction Materials.

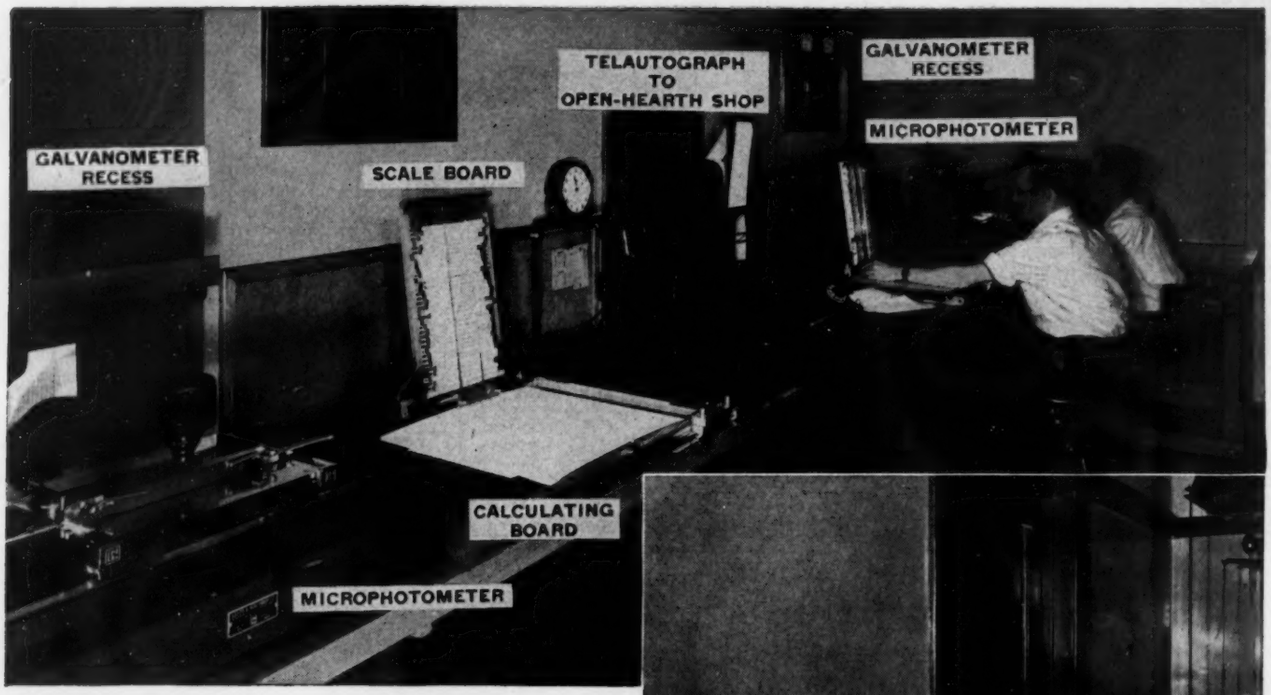
For over 60 years, the J-M label on friction materials has meant exceptional durability, high mechanical strength and resistance to heat and shock. Designed in the J-M Laboratory . . . and thoroughly tested under actual service conditions, these friction materials combine maximum braking efficiency with economical operation.

Today, these fine friction materials are serving leading steel mills on cranes and other equipment . . . efficiently and economically. For details about the complete line of J-M Friction Materials, or for special help on friction material applications, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

INDUSTRIAL FRICTION MATERIALS



Above, room containing Vincent-Sawyer Microphotometers in a steel mill's spectrochemical control laboratory. Here five men handle the control and heat analyses for the open-hearths and electric furnaces. The other three men on the shift stepped out of this picture so we could show the microphotometer at the left.

Steel Analyzed in Minutes With New Microphotometer

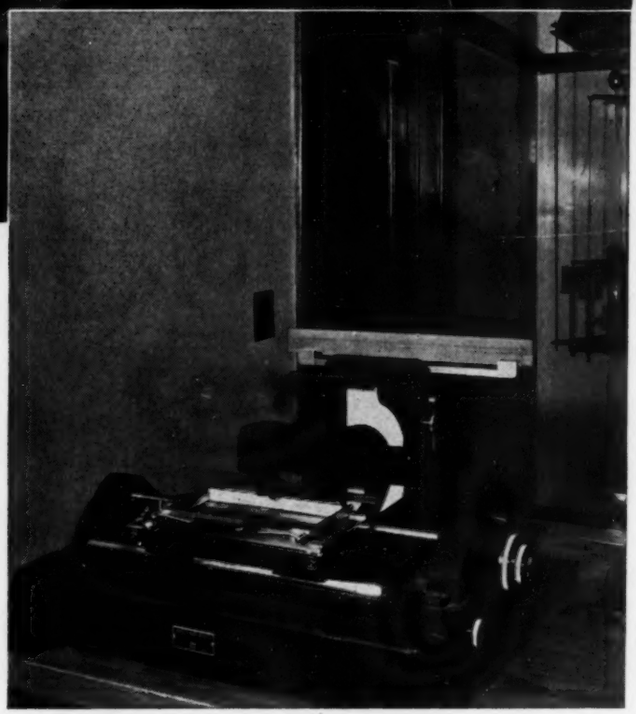
An average of 15 minutes from the time a sample is received until the composition has been reported — that is the speed of routine analyses in an Eastern steel mill.

This extra-fast analysis, accomplished with the L&N Vincent-Sawyer Microphotometer, enables open-hearth and electric furnace helpers to bring the analysis of each melt closely to specifications; cuts the total time per heat.

Samples from electric furnaces and open-hearths are sped by pneumatic tube to the laboratory, where exposures (spark or arc as required) are taken, developed and sent to the microphotometer room. An operator next measures densities of preselected spectrum lines with the microphotometer. Another operator translates density ratios into percentages of elements, and the foreman then examines the analysis and sends it by Telautograph to the open-hearth shop.

Designed for rapid, routine analyses rather than for research, the L&N Vincent-Sawyer Microphotometer has the following advantages in addition to speed:

1. Exceptional accuracy and stability. Positioning of the spectrum plate is rapid and highly precise. Photoelectric scanning is sharp and accurate. Indicator is an L&N Type HS Galvanometer whose high sensitivity makes an amplifier unnecessary; readings are free from pick-up.



Close-up view of Microphotometer and galvanometer assembly.

2. Easy and simple to use. Operation requires only a few simple, natural motions and a minimum of eye movement — important factors in reducing fatigue and error.

The instrument is described in detail in an 8-page folder which we'll be glad to send on request. Ask for Reprint E-90(1).

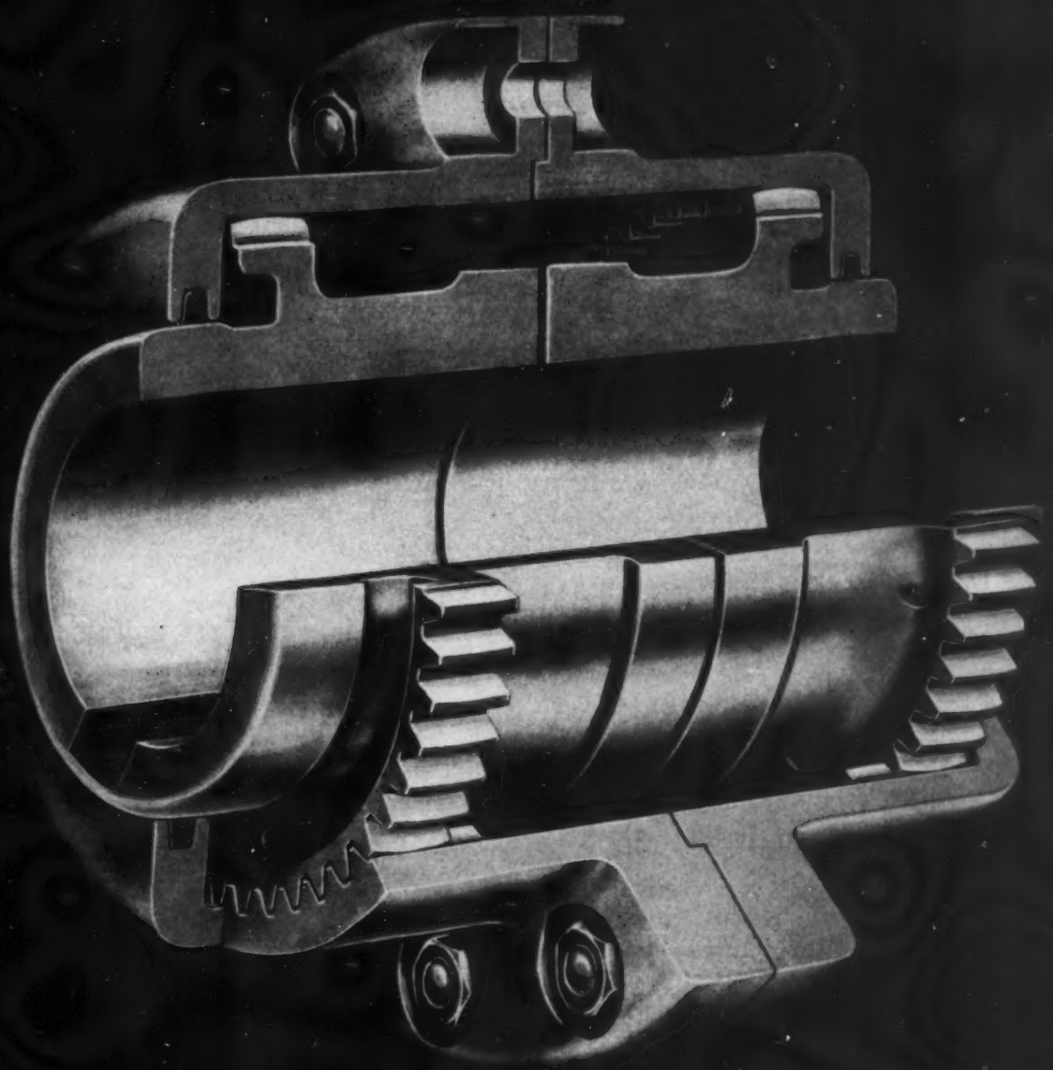
LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Ir. Ad E-90(4)

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

● *Typical mounting of SKF Thrust Bearing in a MORGOIL Bearing for the Back-up Rolls of a large 4-High Mill.*

Photo courtesy of the Morgan Construction Company

Designed to carry the heavy thrust loads on back-up rolls, this double directional adaptation of the SKF Spherical Roller Thrust Bearing has all the desirable features:

1. *High thrust capacity.*
2. *Rolling alignment.*
3. *The ability to run at sustained high speeds.*
4. *Very low friction.*

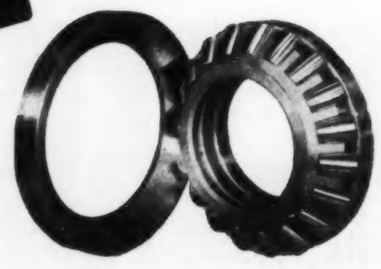
Specify SKF — the Right Bearing in the Right Place.

6146

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

SKF

SPHERICAL ROLLER THRUST BEARINGS



3000 pounds per hour...

75% investment savings

with the Salem Continuous Rod Heat Treating Furnace

Continuous Rod Heat Treating Furnace recently designed, built, and installed by the Salem Engineering Company, builders of all types of heating furnaces and allied equipment.

● When you invest company funds in a major installation like a rod heat treating furnace, you want the best equipment money can buy. And in a Salem continuous furnace, you'll have just that . . . plus substantial savings in fuel, labor costs, maintenance expense and original installation cost.

Installing a Salem furnace takes about 25% of the investment usually required by other types of heat treating furnaces. The Salem furnace heats round or square rods, carbon or alloy steel, in sizes from ½" to 3". Quenching can be done in either water or oil, and the elapsed time between furnace and quench is only 2½ seconds.

Producing at a rate of 3,000 pounds per hour, the furnace operates with one man at the charge end and one at the discharge end. Bar stock continues through the furnace automatically, the larger sizes being discharged one at a time, and the smaller sizes in small groups. Furnace temperatures range from 1600° to 1800°F., and each piece goes through the same heating cycle as any other piece, so that there is complete uniformity in the heating operation.

Salem's conveyor system is enclosed in the furnace, so there is no reheating of conveyor parts. The stock travels through the chamber in position at all times, assuring proper discharge into the quench. Few, if any, other furnaces provide such an arrangement.

Let Salem engineers give you complete information on the continuous rod heat treating furnace. Call or write today.

SALEM ENGINEERING CO.

SALEM, OHIO

TORONTO, ONTARIO, CANADA LONDON, ENGLAND

...an aluminum conductor for every bus installation!

Alcoa makes conductors to meet all of your electrical bus needs—for indoors or out-of-doors, for short or long runs, for heavy or light power loads. Aluminum connectors and supports can also be supplied. Joints may be welded, if desired.

DO YOU HAVE THIS BOOKLET?

"Alcoa Aluminum Bus Conductors" contains a lot of general data which are helpful in the selection of conductors and in bus layout. We'll gladly send you a copy.

Alcoa engineers will answer your specific questions on aluminum bus conductors. For this help, call the nearby Alcoa office. Or write ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

IN EVERY COMMERCIAL FORM

UNITED 46 x 100
BLOOMING MILL

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

PLANTS AT PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON
SUBSIDIARY: ADAMSON UNITED COMPANY, AKRON, OHIO
AFFILIATES: DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND
DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q. CANADA

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

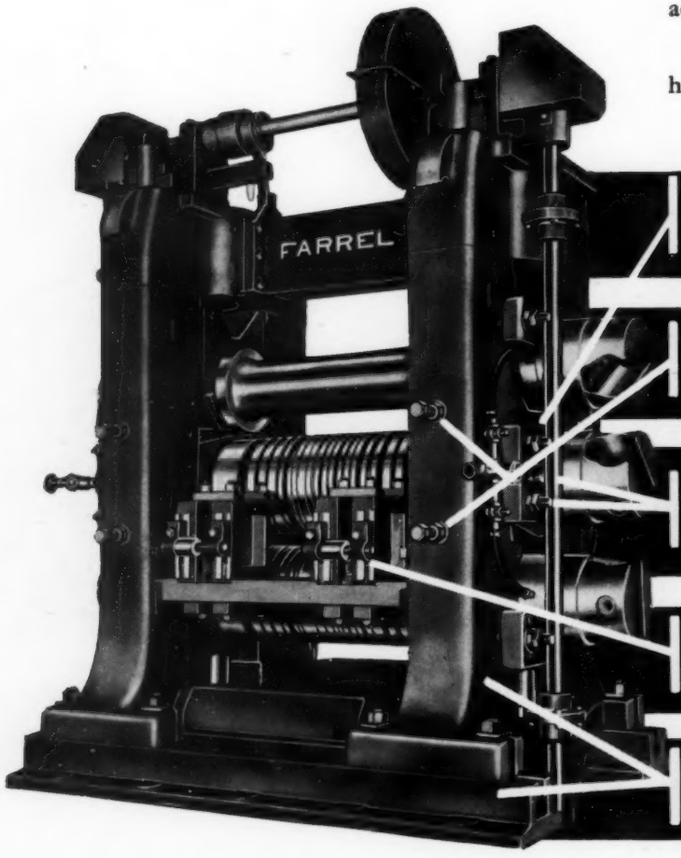
REG. T. M.

How Farrel FORTIFIES EFFICIENCY in this "EDGE CORRECTING" MILL

By design and construction Farrel gives this 18" x 49" mill the ability to maintain accuracy and efficiency despite continuous heavy duty edging bar stock from several flat pass mills.

This key unit in the rolling mill line has forged steel rolls with accurately matched grooves to handle various sizes of rectangular bar for successive passes. The mill maintains the width gauge of the bar and edges it to the form of the roll groove bottoms, correcting any edge irregularities developed by the various flat passes. The top roll acts only as a driving shaft for adjoining mills.

Here are some of the details showing how Farrel has protected operating efficiency in this mill:



Steel roll journal bearing chocks are lined with phenolic bearing material and equipped for water lubrication.

Screw adjustment to compensate for wear of liners is provided on upper and lower bearing chocks of fixed roll.

Vertical adjustment of bottom roll is by electric motor through two sets of reduction gearing. Horizontal adjustment to set grooves in accurate alignment is also provided.

Adjustable roller guides on the entry side facilitate feeding, while on the take-off side pick-offs remove and guide the bars away from the bottom roll.

Heavily proportioned housings and caps of cast steel are mounted on substantial stringer bedplates of Meehanite.

FARREL ROLLING MILL MACHINERY

Rolls	Mill Pinions
Rolling Mills	Pinion Stands
Rod Mill Tables and Manipulating Equipment	Gear Drives of any Capacity
Universal Mill Spindles	Flexible Couplings
Rod Coilers	Roll Grinding Machines
Gears	Roll Calipers
	Lead Presses for Pipe or Rod

Complete information on this or other Farrel rolling mill equipment will be sent promptly, on request.

FB-347

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

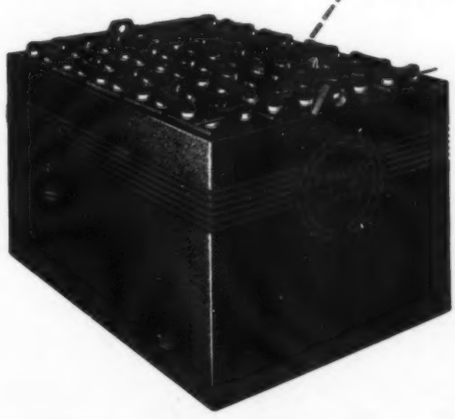
Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, Stonington, New York, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston, Charlotte.

Farrel-Birmingham

Get the 10% Extra Capacity in MODERN PHILCO BATTERIES

For hard continuous work, Philco pioneered the modern extra capacity battery that provides 10% additional capacity with no increase in overall dimensions. This great advantage was first made available in Philco Type XL and XVL Batteries, and is an outstanding feature of the famous Philco "Thirty" . . . the battery with 30% longer life. For today's heavier work schedules, make sure of *all* the capacity you can get. Specify a modern Philco. Write today for new catalogs.



PHILCO CORPORATION • STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

PHILCO

FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

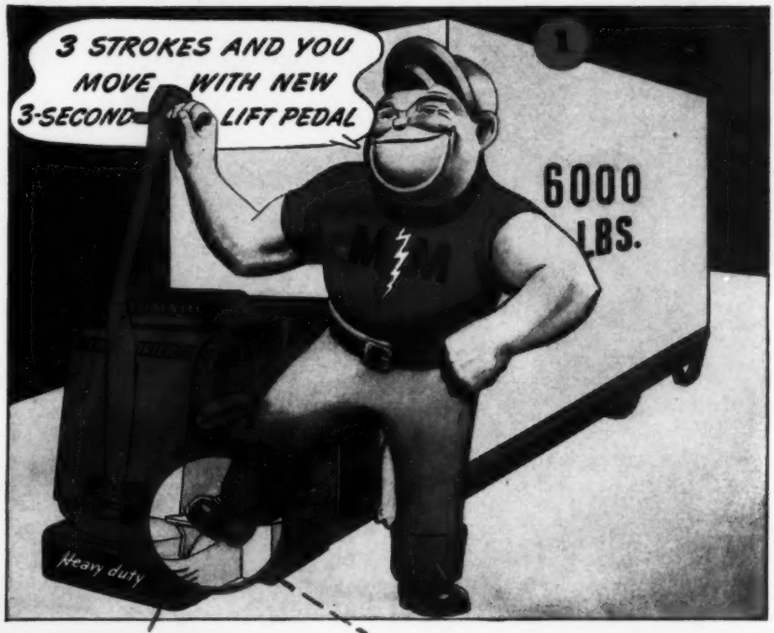
Amazing New Postwar Transporter Lifts Loads Faster... *Moves Loads Easier!*

Adds New Efficiency, Longer Life to Miracle Electric Truck

Yes, you get more—much more in the amazing NEW, POSTWAR TRANSPORTER—the miracle electric truck long famed for cutting handling costs in half and taking the work out of every material moving job.

Astounding new money, time and work saving features have been added. Developments that lift loads faster, move them easier, give longer life and greater efficiency to a unit already noted for energy-saving performance.

With practically everything new but the hardware, the features below only highlight what you will get in the 1946 Transporter. Send the coupon. Get *all* the facts, before you decide on any motorized hand truck.



"TOUCH-OF-YOUR-THUMB" EASE, *says... "MUSCLE MIKE"*

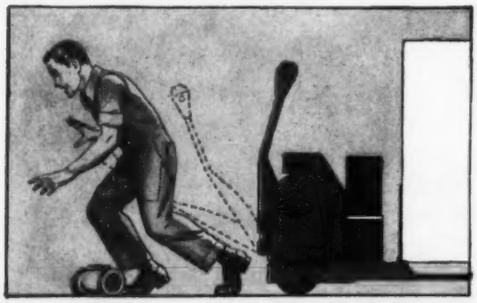
The new 3-second Lift Pedal contains two pistons or cylinders, the high pressure (low speed) cylinder being housed inside the low pressure (high speed) piston. Both cylinders are actuated by the cam when the foot pedal is depressed. One stroke of the foot pedal is all that is required to engage skid.

When load resistance is encountered, the fluid from the larger or low pressure cylinder by-passes back into the reservoir, and the high pressure cylinder is employed to raise the load.
So the first stroke of the foot pedal engages the load, and two more strokes raise the load sufficiently to move.

2 EASY TO GET AT POWER UNIT

Changes in design have been made, so that all parts of the power unit are easily accessible. The wiring system has been simplified, and component parts compactly placed where they can be reached easily for lubrication, and inspection.

3 NEW SAFETY BRAKE



Complete "dead-man" control is assured by a double shoe external contracting type larger diameter brake, which provides four to five times more braking effort. This gives you a Positive Mechanical Brake more efficient and safer the instant control handle is released to upright position.

FOOT PEDAL HINGES BACK FOR SHORTER TURNING RADIUS

To provide a shorter turning radius, the foot pedal is hinged back when not in use for lifting.

4 Double-Pitch Reduction Chain Drive Prolongs life of unit.

5 New Magnetic Contactor Utilizes Silver Alloy Tips to give ten times more life.

6 Carbon Brushes in Commutator Type Collector Ring Replace Copper Fingers to eliminate lubrication, increase wearing quality.

Approved by Underwriters' Laboratories, Inc.

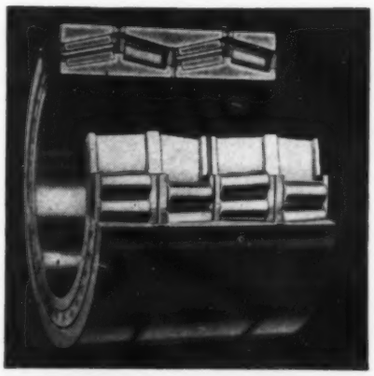
Transporter
A PRODUCT OF AUTOMATIC
Lightens LIFE'S LOADS

AUTOMATIC TRANSPORTATION COMPANY
Div. of The Yale & Towne Mfg. Co.
47 West 87th St., Dept. W, Chicago 20, Illinois
Please mail me without cost or obligation, complete facts about the NEW Postwar TRANSPORTER.
( ) Have an A. T. C. Specialist call and survey my material handling costs.
Company Name.....
By.....Position.....
Street Address.....
City.....State.....

LOOK TO THE LEADER FOR ALL THAT'S NEW

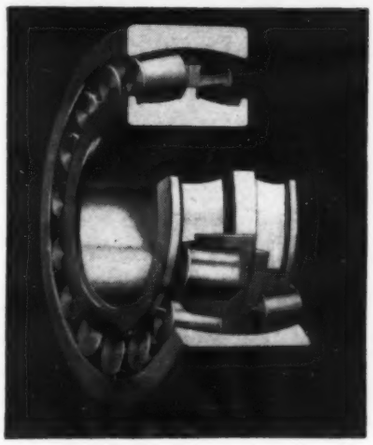
FOR MORE OUTPUT, LESS MAINTENANCE
SPECIFY TORRINGTON BEARINGS

With the trend in steel mills toward production at lower cost, comes the demand for equipment that "rolls it out" faster with fewer and shorter shutdowns for maintenance. Shown on this page are some typical Torrington Bearings for steel mill applications. Designing and building bearings—large or small—special or standard—to meet specific requirements, has for years been a function of Torrington's Bantam Bearings Division. Our engineers will gladly help yours to incorporate Torrington Bearing advantages into machines you build or operate.



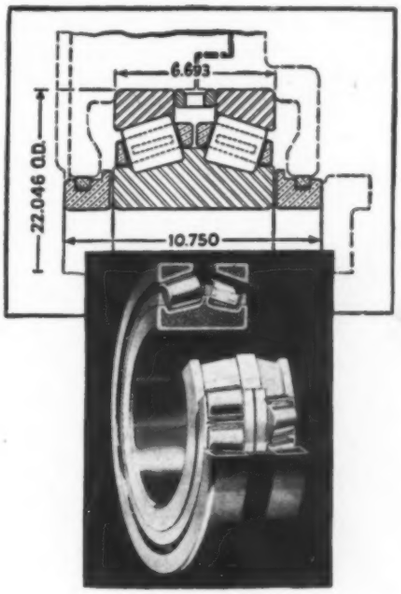
HIGHER ROLL NECK SPEEDS

and maximum service life are attained by use of Torrington Tapered Roller Bearings. Four-row taper type bearing shown here is used on the roll necks of Mesta five-stand mill. These bearings handle loads efficiently, assure long and trouble-free service life.



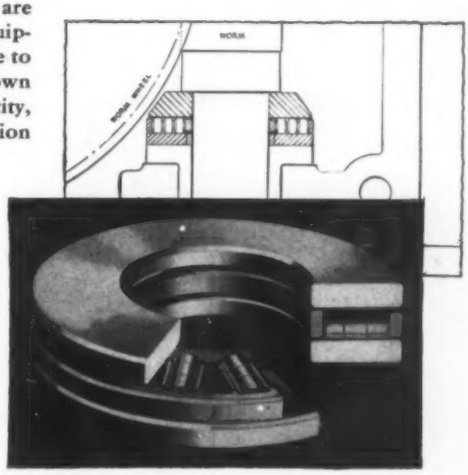
PEAK TONNAGE RECORDS

come easier when Torrington Two-Row Tapered Roller Bearings made of S.A.E.-3310 steel (with higher nickel content) carry the thrust loads imposed on back-up rolls. Bearing shown here was designed for 80" four-high continuous hot strip mill. Features include simplicity of design for positioning in housing; clearance adjustment to permit assembly as received; and take up as required, with spacer width control.



SELF-ALIGNMENT

under high load stresses, shaft deflection or misalignment is assured when Torrington Self-Aligning Spherical Roller Bearings are used in modern, high speed auxiliary equipment for steel mills. Especially adaptable to heavy-duty performance, the bearing shown also offers two-directional thrust capacity, high radial capacity, and unit construction for easy installation.



LESS MAINTENANCE ATTENTION

is needed when screw downs turn on Torrington Roller Thrust Bearings. Bearing shown here is used on four-high screw downs. Specifically designed to handle tremendous loads at high speeds, it helps the mill deliver more work for less power . . . stay on the job longer with less interruption . . . give more years of dependable, trouble-free service.

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

R-S FURNACE FACTS

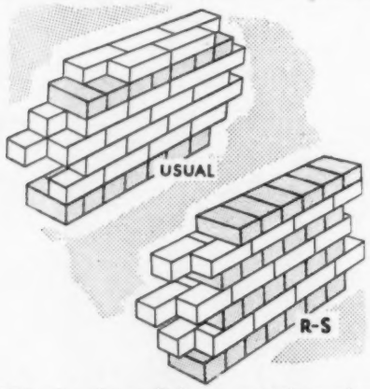
ISSUED MONTHLY BY R-S PRODUCTS CORPORATION, PHILADELPHIA 44, PA., FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

Two More R-S Ingenuities With A Life-Purpose

The eight little ingenuities in R-S furnace design which we reported in September and October seem to have caused quite a stir of interest. That's good. If a few of the "tricks of the trade" we've learned in 38 years of furnace building can help you toward better metal heating, FURNACE FACTS is a success for sure.

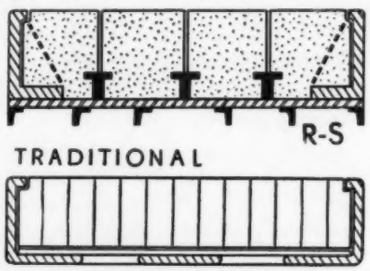
So here are two more.

The usual furnace lining is laid up with a header-course every 5 or 10 courses.



This ties the wall layers together—gives the lining an interlocked structure to resist the strains of expansion under heat. But at R-S we go further. We take the extra time to see that our bricklayers use a header pattern *on every other course*—to carry a sound principle all the way.

As for door frames, their traditional form is a one-piece casting, cored out to receive the refractories required. But not at R-S. Our frames are cast, to be sure—but in sections to allow movement—*and the frame isn't the load-carrying member.* The basic member of every R-S door (however small) is a reinforced steel plate. On it are hung all the frame castings, and to it are tied all the ceramic shapes. Result—longer life, surer sealing, less repair, lighter weight.



PHURNACE PHILOSOPHY

A desk engineer from Purdue
Thought a cheap home-made furnace would do.
Now, all night he marches,
Twisting valves, patching arches.
And the same thing might happen to you!

New R-S User . . . Car-Hearth for Cast Work

Crown Cork & Seal, Machine Division—all-purpose gas-fired car-hearth furnace for new plant in E. Baltimore—bought on basis of excellence in technical detail and versatility of usefulness—primary work performed is stress relief, and the heat treatment of heavy cast parts for Crown's remarkable automatic bottling machinery.

We learn, by the way, that the demand for beer and carbonated beverages is bigger than ever—and booming the bottling machinery industry.

McDonough's Death Sudden Loss To R-S and Cleveland Steel Men

Amid the bustling business of metal heating and heat treating, many of us paused last month to mourn the sudden passing, on September 8, of W. R. McDonough, 64, head of W. R. McDonough & Co., sales engineers for major steel industry suppliers since 1918—among them R-S Products, Furnace Division. The cause was a heart attack, which struck while "Bill" was en route home from a holiday at his summer lodge at Stokes Bay in Canada.

An Invitation

to discuss modern furnace design with R-S engineers and field men

1946 National Metal Congress and Exposition
Atlantic City • November 18-22

Inquire for the R-S Suite • Hotel Claridge

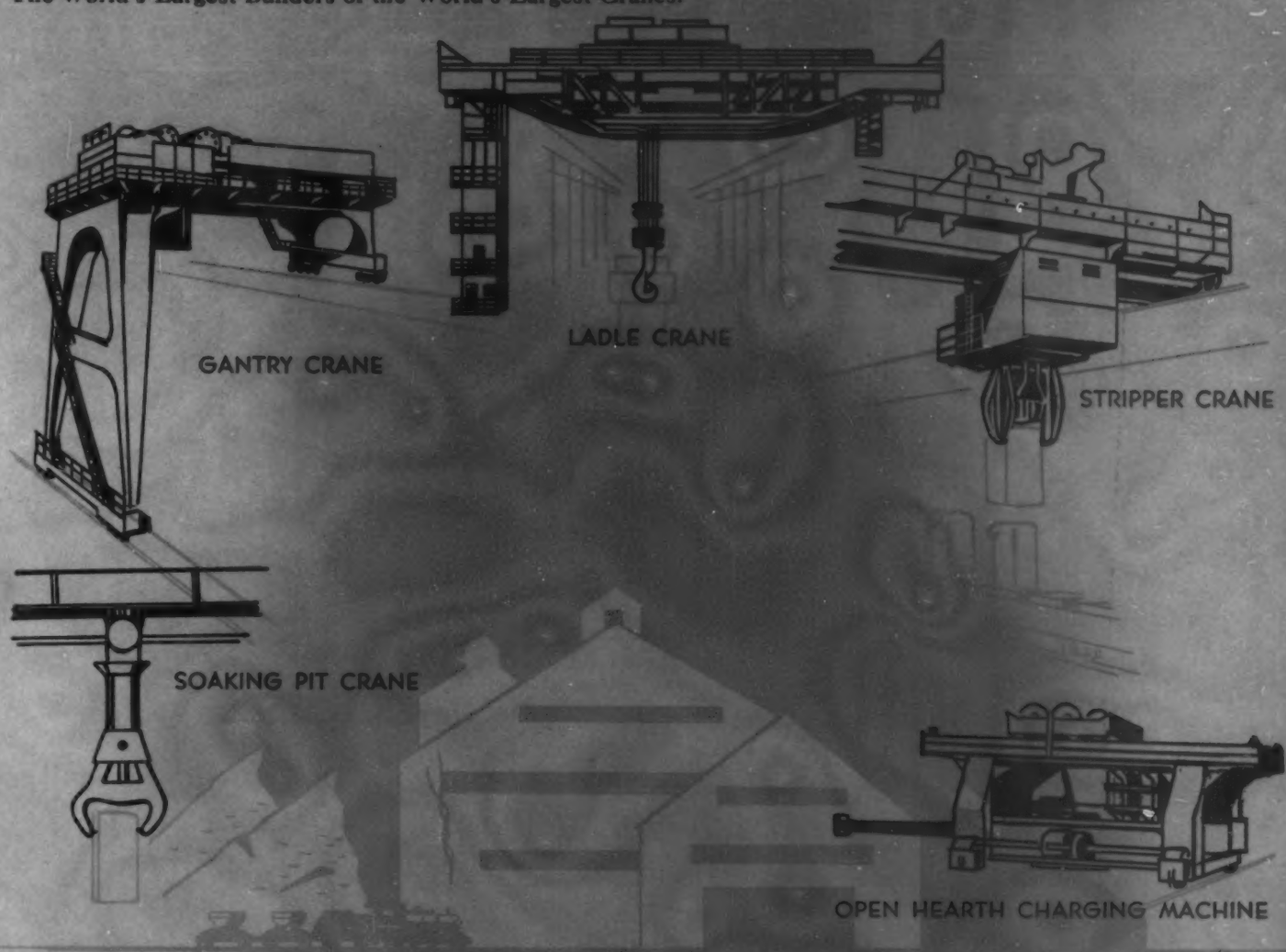
JMLco-PL-1

World's Largest Builder of the World's Largest Cranes

Alliance

Alliance makes the equipment to move slabs, ingots, hot metal, raw material and finished products safely, quickly, and easily.

For 50-odd years, Alliance has been known as The World's Largest Builders of the World's Largest Cranes.



THE ALLIANCE MACHINE COMPANY

ALLIANCE, OHIO · 1622 OLIVER BLDG., PITTSBURGH, PA.

Quick-As-Wink

HUNT CONTROL VALVES

Split-Second Control of Two Cylinders with One Valve . . .

Here's an example of positive control.

One Quick-As-Wink valve controls double acting cylinders. One cylinder always leads the other on the work stroke and lags the other cylinder on the return stroke.

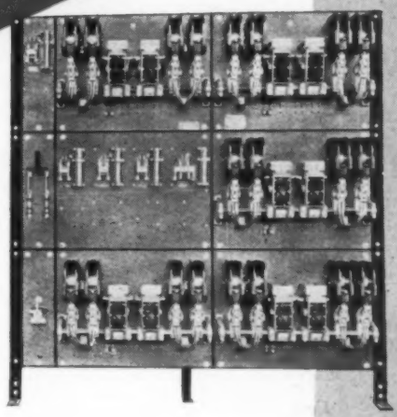
Stainless steel body and plunger eliminate corrosion and U-packers seal valve against costly air leaks. All Quick-As-Wink valves are designed for simplicity of operation, speed, accuracy and long life.

Available in many different actions, all standard and many special sizes. Complete information in the C. B. Hunt engineering catalog, *available upon request.*

This Tube Beading and Flaring Machine is a product of the Vaill Engineering Co., Waterbury, Conn. To bead or flare, the operator simply inserts the end of the tubing into the machine, depresses and raises the hand lever and then withdraws the finished work. The time consumed is less than it takes to describe the operation.

C. B. HUNT & SON, Inc. SALEM, OHIO

EC&M 2300 VOLT WOUND-ROTOR *Motor* CONTROLLER

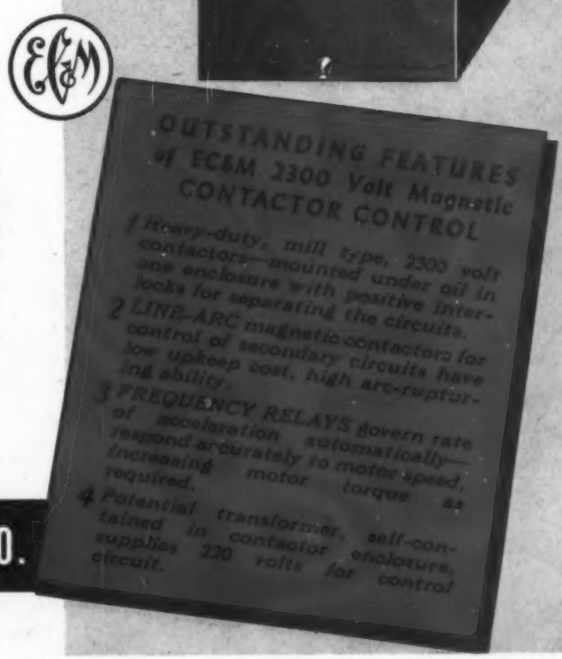


For 2300 volt, wound-rotor motors, EC&M Non-reversing or Reversing Control is without equal. And for the primary, high voltage switching requirements, Type ZHS Magnetic Contactors are used.

These contactors are of compact design and oil-immersed, with the control circuit potential transformer, in a single shock-proof enclosure. For reversing applications, as used on this 18-inch mill, two contactors are mounted back-to-back with heavy, mechanical interlock-bar between them and enclosed under oil in one tank.

Panels for controlling the secondary, or rotor, circuit consist of *LINE-ARC* Contactors and Frequency Acceleration Relays. Type NX Master Switch gives speed control.

Specifications of these EC&M Wound-rotor Motor Controllers are given in Bulletins 1062-C, 1140-B, and 1182-2. Write for your copies.


OUTSTANDING FEATURES
of EC&M 2300 Volt Magnetic
CONTACTOR CONTROL
1 Heavy-duty, mill type, 2300 volt contactors—mounted under oil in one enclosure with positive interlocks for separating the circuits.
2 LINE-ARC magnetic contactors for control of secondary circuits have low upkeep cost, high arc-rupturing ability.
3 FREQUENCY RELAYS govern rate of acceleration automatically—respond accurately to motor speed, increasing motor torque as required.
4 Potential transformer, self-contained in contactor enclosure, supplies 220 volts for control circuit.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79th STREET • CLEVELAND 4, OHIO

Pioneered by North American

LUMINOUS OR LONG FLAMES
with either gas or oil are produced by the Series 113 Burners. They are desirable for vast coverage, for fewer burners and for uniformity of flame temperature.

SHORT FLAMES
are produced by the Series 221 Burners. These burners provide a highly stable and efficient fire, using either gas or oil. They are recommended wherever heating in a relatively small space is required.

WRITE FOR DESCRIPTIVE LITERATURE

DUAL-FUEL BURNING SYSTEMS FOR GAS AND OIL

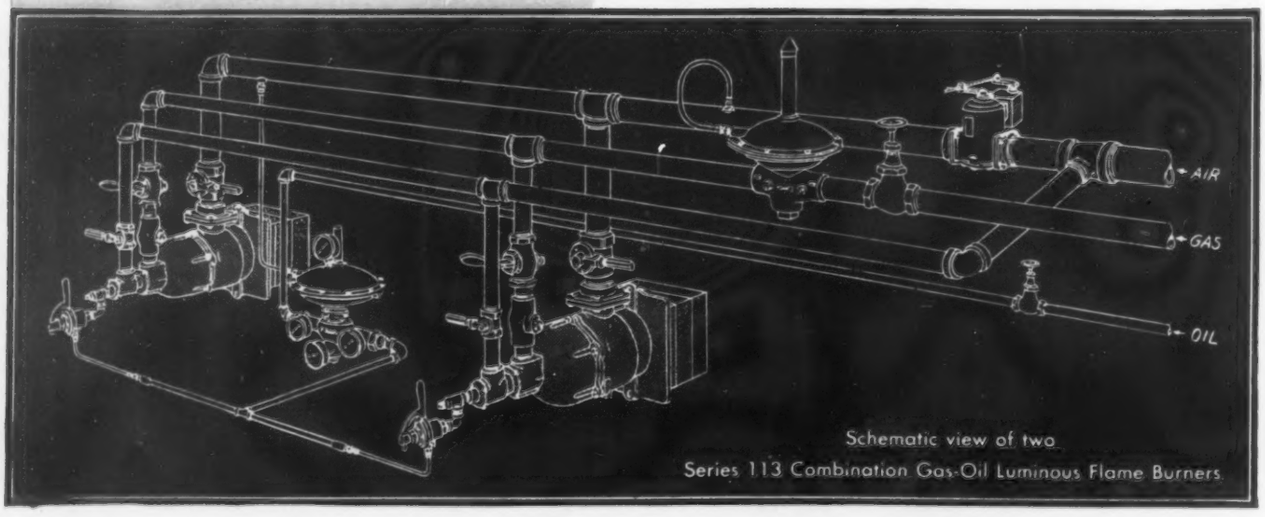
MAXIMUM EFFICIENCY WITH EITHER FUEL

SWITCH FUELS INSTANTLY

AUTOMATIC FUEL-AIR PROPORTIONING

WIDE TURNDOWN RANGE

THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES AND FIELD ENGINEERS IN PRINCIPAL CITIES
CLEVELAND 4, OHIO

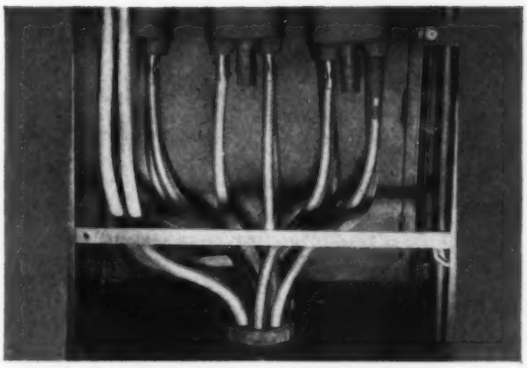


Schematic view of two
Series 113 Combination Gas-Oil Luminous Flame Burners

WIRE and CABLE USERS

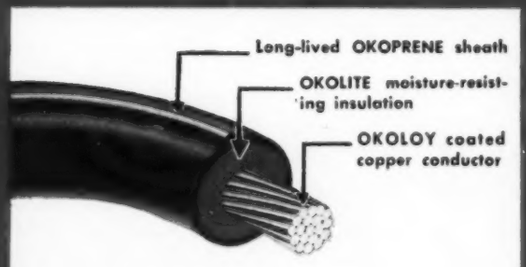
WROTE OWN "SPECS" for RESEARCH LABORATORY

Before equipping their new and completely modern laboratory, the engineers of a world-famous research organization decided to write their own specifications. Drawing on the extensive experience and test results of their own, they called for wires and cables insulated with an oil-base compound protected by a sheath of neoprene. *They knew what they wanted:*—wiring that would resist flame, moisture, heat and chemicals. *They GOT what they wanted:* — Okolite-Okoprene* cables shown in pictures below. The job is described in Bulletin OK2035, the cable in Bulletin OK2009-C both available on request. The Okonite Company, Passaic, N. J.



Connections for one of three 208-volt ring mains in cellar of laboratory at low side of 4150 volt distribution transformer. The 4/0 Okolite-Okoprene cables are colored blue, red and black for phase identification.

Taps being made in 3' x 3' distribution manhole. Exposed section of conductor and connector insulated with Okonite splicing materials. Okolite-Okoprene cables were specified for tough, damp locations.



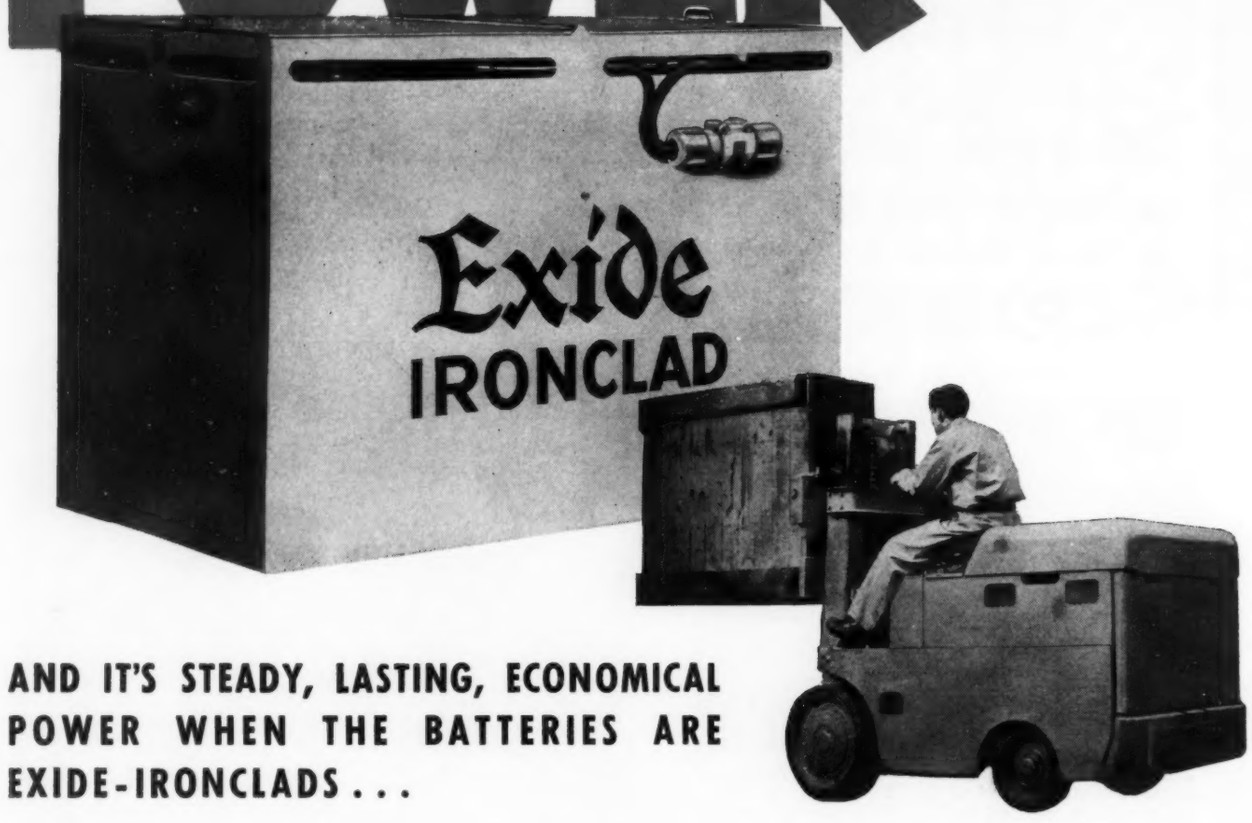
OKOLITE-OKOPRENE cables offer such additional advantages as:— no braids to rot . . . simple, flexible, long-lived construction . . . tough weather-resistant jacket of uniform thickness requiring no other covering . . . high surface resistance that eliminates surface discharge . . . 75°C operation.

OKONITE RUBBER TAPE AND MANSON FRICTION TAPE offer a combination known the world over for dependable protection and high quality in jointing and splicing operations. Okolite High Voltage Corona-Resisting Tape and Okonite Cement help round out a complete line of tapes and splicing materials. For additional data, write for Bulletin 1007.

*U/S. Pat No. 2,312,058

OKONITE insulated wires and cables

DEPENDABLE POWER



AND IT'S STEADY, LASTING, ECONOMICAL POWER WHEN THE BATTERIES ARE EXIDE-IRONCLADS . . .

More and more, management executives are finding that Electric Industrial Trucks, powered by Exide-Ironclads, are the *right answer* to their materials handling problem. Numerous records prove that this efficient combination assures more tons per man per hour . . . and at lower cost, which means greater profits.

Exide-Ironclad Batteries deliver continuous service day in and day out for years. They have the *high power ability* required for frequent "stop and go" service . . . the *high maintained* voltage that constant lifting, hauling and stacking demands . . . and the *high capacity* needed to assure steady, day-long performance with full shift availability.

Write us for a FREE copy of Exide-Ironclad Topics which contains "Case Studies" of materials handling problems. It tells how to cut handling costs up to 50% . . . covers latest developments in handling materials from receiving to shipping.

Materials Handling offers one of the greatest opportunities for reducing costs and increasing profits, that are available to Management today.

ELECTRIC INDUSTRIAL TRUCKS POWERED BY EXIDE-IRONCLADS HAVE ALL THESE FEATURES . . .

- Inherently dependable
- Built for long, hard service
- Provide maximum safety . . . best working conditions
- Fast handling and accurate spotting
- Effective use of lowest cost power
- Lowest overall cost

HIGHEST EARNINGS
GREATEST SAVINGS

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto

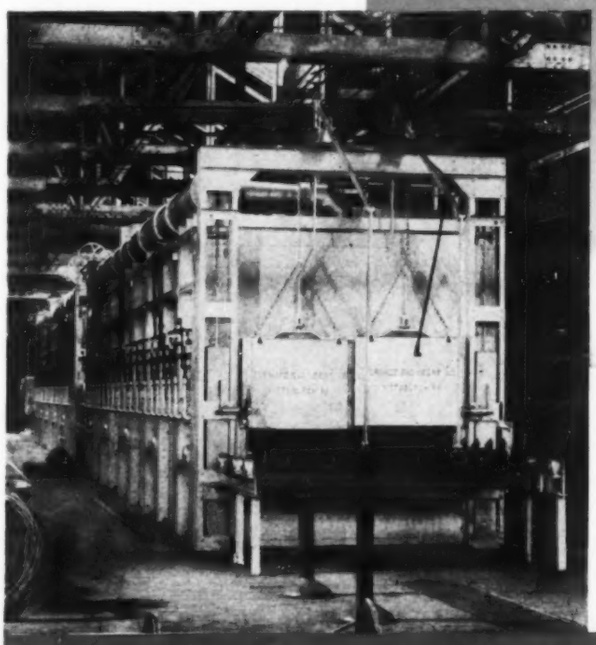
DO YOU WANT *Optimum* RESULTS?

Equipment Produces Quality Controlled Products

Patented Combustion System Increases Production

Burners Reduce Fuel Costs Per Ton

Equipment Engineered For The Wire Industry



Direct fired cover annealing furnaces.

Spheroidizing, normalizing and bright annealing furnaces.

Patenting and galvanizing furnaces.

Lead and salt furnaces for Isothermal, Martempering and Austempering treatments.

Salt bath descaling furnaces for alloy and stainless steels, etc.

F. E. I. patented burners and combustion system can be installed on existing furnaces.

We invite your inquiries on equipment where hardness, physical properties and structure are required to meet present day requirements on a tonnage basis.

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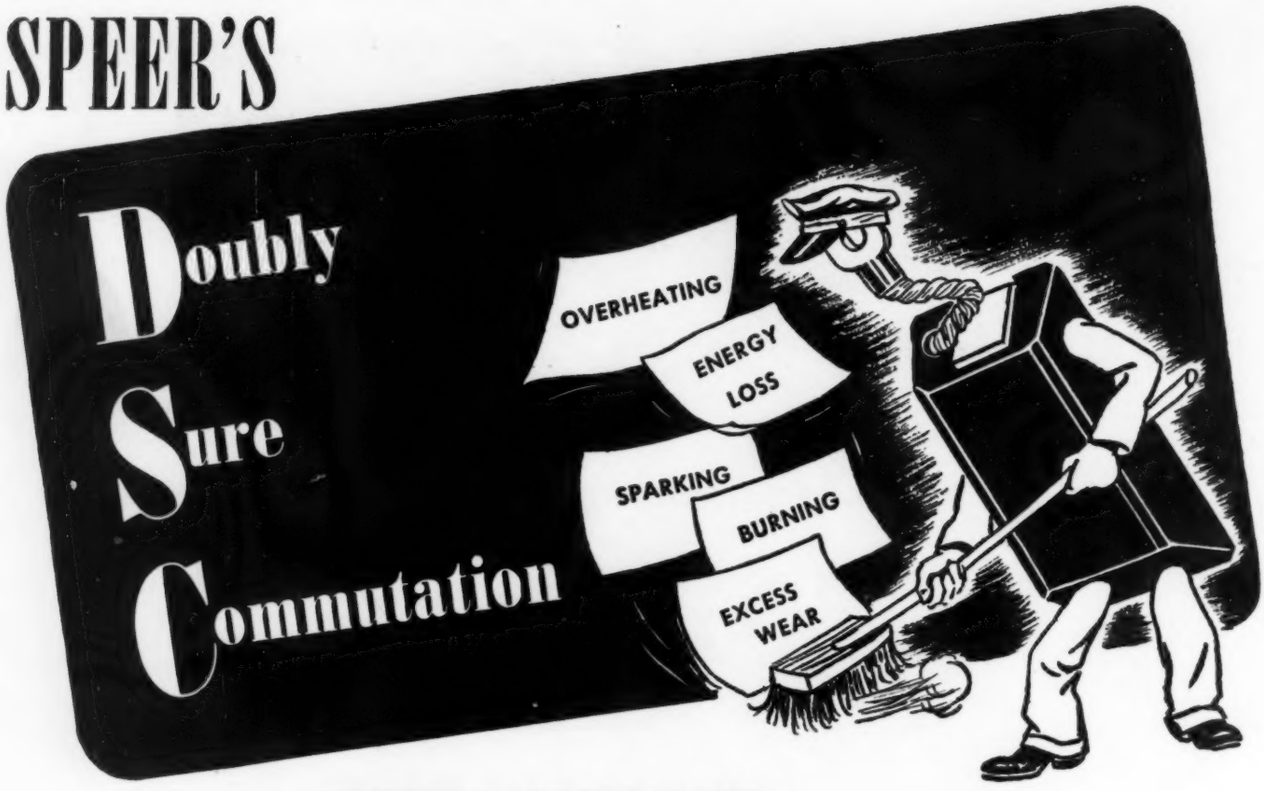
FOR EUROPE, ASIA, AFRICA: Salem Engineering Co. Ltd., Milford, Nr. Derby, England.

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

SPEER'S



. . . HELPS CLEAN UP BRUSH TROUBLES

Let Speer's brush-matching service cut brush renewal and maintenance costs for you . . . clean up the causes of poor commutation.

That way you're *doubly* assured of getting improved commutation and peak performance because Speer matches brushes to your motors and generators *two* ways — mechanically *and* electrically. Speer has specialized in this *two-way* matching of brushes for nearly half a century. From the all-inclusive Speer line of standard and special carbon, graphite, electrographite, and metal-graphite brushes, Speer can supply the grades best suited to the characteristics and service conditions of *your* machines.

So for utmost freedom from such brush troubles as burning, sparking, overheating, and excessive wear and energy losses — for brushes perfectly matched to your machines — call on Speer. Write for Brush Data Forms.

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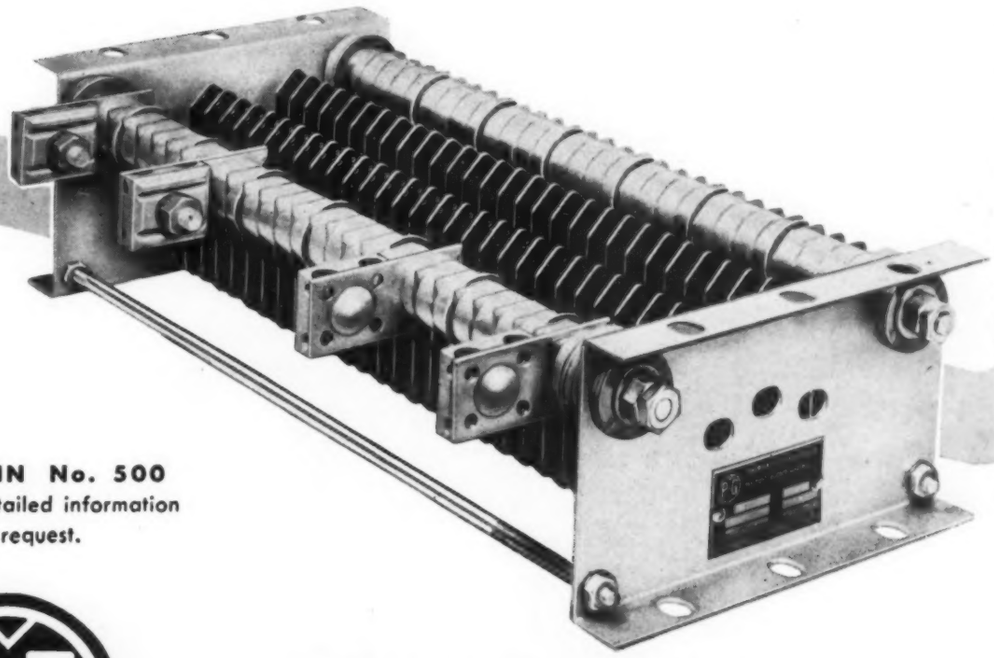
SPEER
CARBON COMPANY
ST. MARYS, PA.

852

Dependable RESISTOR *Performance*

P-G Steel Grid Resistors are basically dependable because of steel and mica—non-breakable raw materials. With P-G unique grid design, plus sound resistance values and conservative capacities, resistor troubles are minimized. Specify these dependable resistors for your next application.



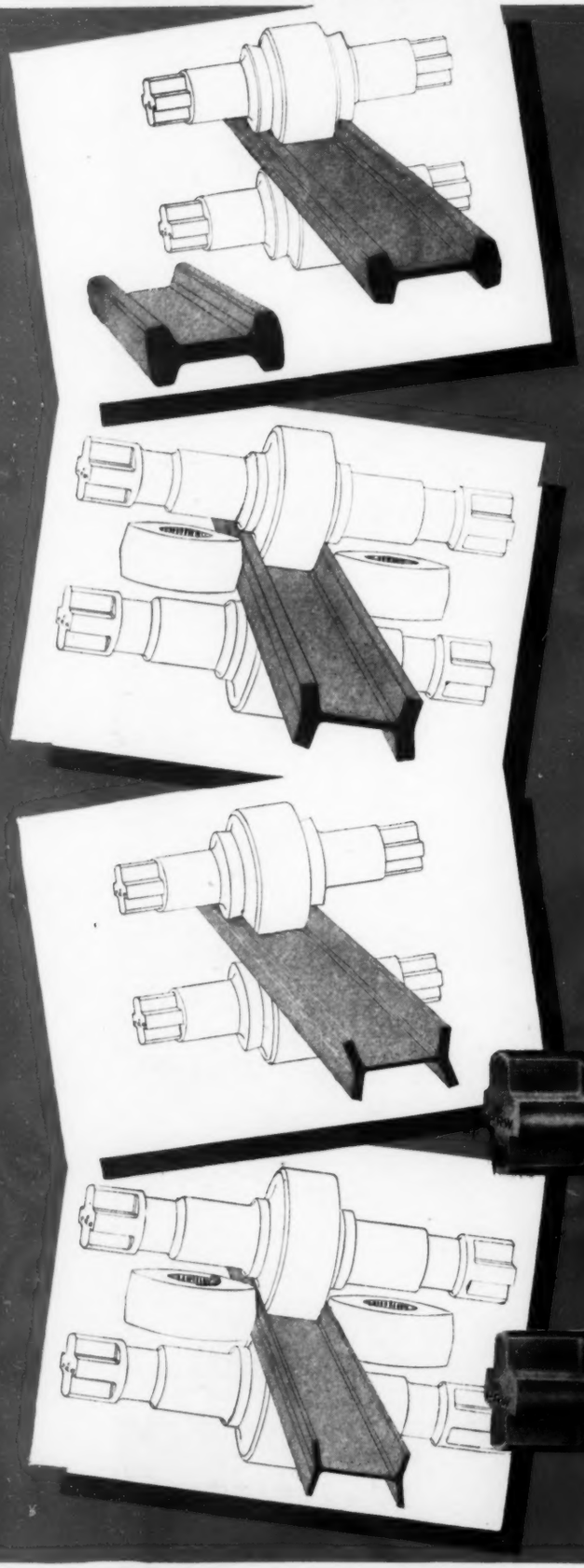
BULLETIN No. 500
Gives detailed information
Copy on request.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY
• ESTABLISHED 1892 •
221 WEST THIRD STREET, CINCINNATI 2, OHIO

ROLLING TECHNIQUE . . .

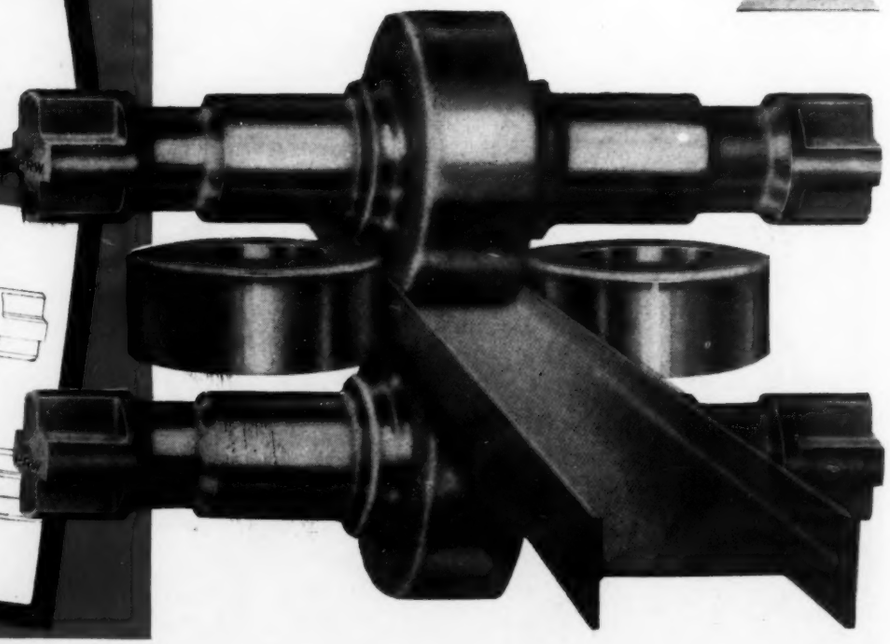


Universal Beam Mills

Although there are very few mills of this type in this country, the tonnage of large beams and large H beams with parallel flanges is counted in the thousands. These mills afford the only means by which these larger sections can be rolled. Here again proper rolls play a large part in producing a quality product.

Pittsburgh Rolls are made by skilled craftsmen whose thorough practical knowledge of metallurgy, foundry methods and accuracy in roll turning is the accumulated result of over seventy-five years devoted to the exclusive manufacture of rolling mill rolls. The use of Pittsburgh Rolls can result only in *less cost per ton of steel rolled.*

PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.



PITTSBURGH ROLLS

IMPROVED REGULATION MEANS **BETTER POWER FACTOR**

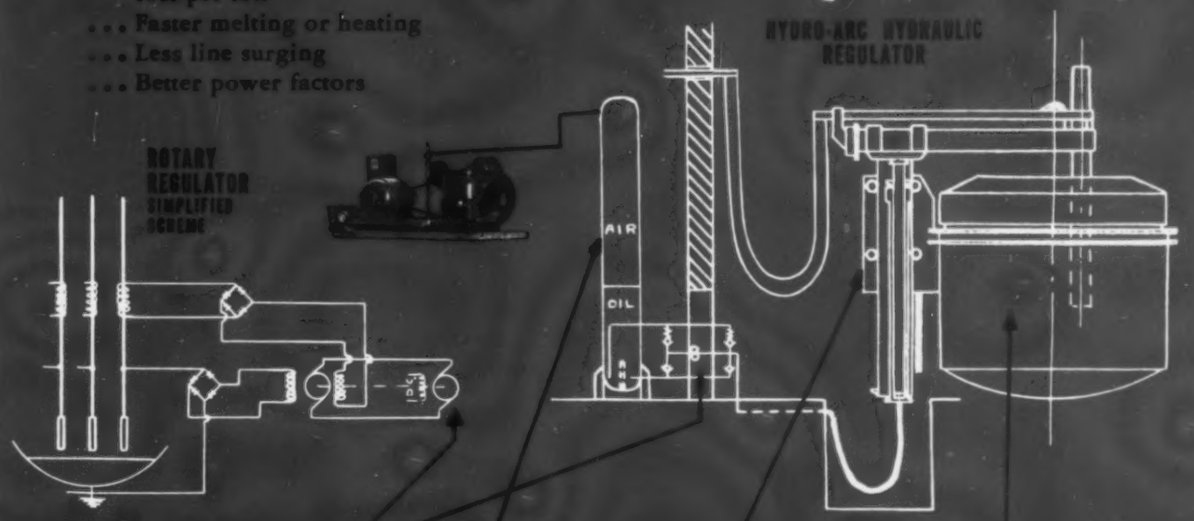
LESS CIRCUIT INTERRUPTIONS PER HEAT OBTAINED

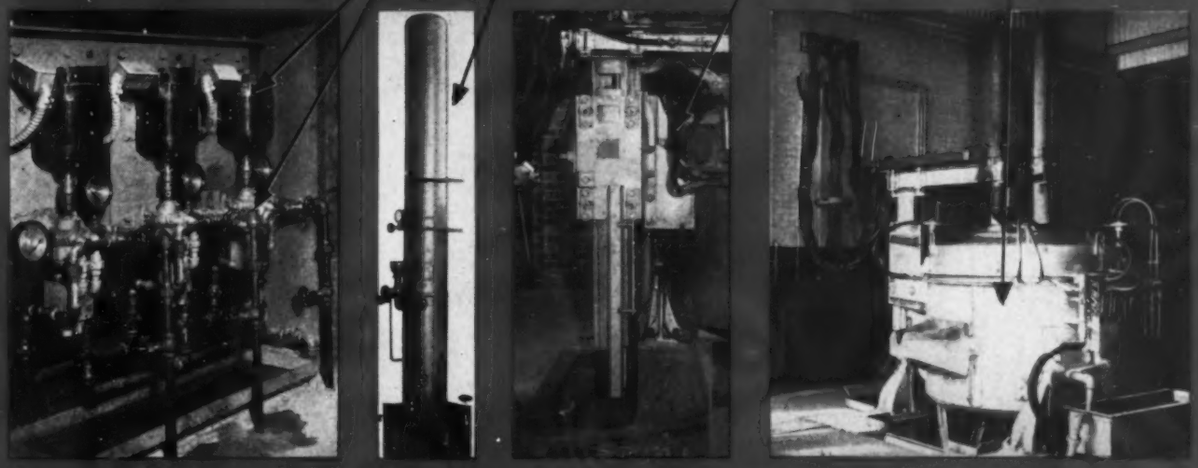
ONLY WITH

Hydro-Arc Furnaces

Hydro-Arc Electric Furnaces have the latest developments of modern direct-arc melting or heating equipment. The hydraulic electrode positioning equipment available only with the Hydro-Arc responds quickly and accurately to every demand of the finest furnace regulator made to date. These two fine units, coupled together like twin links of a chain, give you:

- . . . Better metallurgical control at less cost per ton
- . . . Faster melting or heating
- . . . Less line surging
- . . . Better power factors





COMPLETE INFORMATION MAY BE OBTAINED BY WRITING FOR BULLETIN FY-130

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CORPORATION

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Offices in Chicago, Cincinnati, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis and Washington, D. C. Agents in other principal cities. Canadian Subsidiary: Whiting Corporation (Canada) Ltd., Toronto, Ontario. Export Dept.: 30 Church St., New York 7, New York.

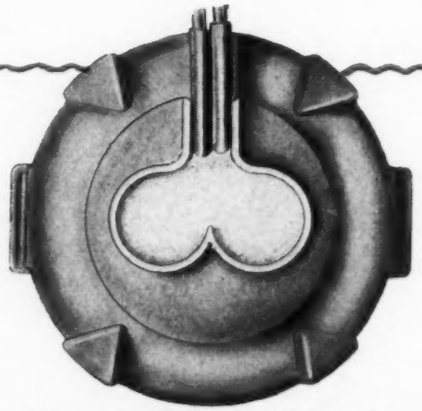
Fibron #5373
flexible plastic tubing

Here is another application where this improved Irvington formulation . . . Fibron #5373 . . . solves an electrical insulation problem involving high temperatures. Hot cement, used to seal the #5373-covered heating elements, has no effect on the flexibility of this unusual plastic. When the heater is in use, the tubing withstands continuous operating temperatures as high as 85° C. #5373 possesses the electrical, mechanical, and chemical properties which distinguish all Fibron tubings. Some of these are:

Dielectric Strength (.020″ wall) wet..1000 V.P.M.
dry..1000 V.P.M.
Tensile Strength, P. S. I. 3000
Life at 105° C. .....2000 hours

Fibron #5373 tubing is available in all standard B & S wire gauge sizes, in six brilliant colors, in heavy wall thicknesses if required—in 36″ lengths, coils, or cut pieces.

Test this unusual product now. Generous samples and additional technical information gladly sent on request.



**Approved by Underwriters' Laboratories for this application*

Short lengths of Fibron #5373 are used to protect the conductor leads on the heating element of the Electra-Serve, manufactured by Electrical Industries, Inc., Newark, N. J. This bottom view of the unit shows where the hot cement seals over the #5373 insulation. Withstanding this heat and high operating temperatures, #5373 tubing retains its flexibility and high dielectric strength.

IRVINGTON *Varnish and Insulator Company* IRVINGTON 11, NEW JERSEY, U.S.A.

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So what?

Roll-Balancing is just one of the improvements in metal-rolling practice developed by Mackintosh-Hemphill engineers with the aid of *your* experienced mill technicians. Your trained mill operators have been responsible, also, for the practical advice which enabled *Mackintosh-Hemphill* engineers to pioneer every major roll development.

As an experienced mill operator, *you* control the rolling conditions and tolerances for each operation. *Mackintosh-Hemphill* engineers establish the metallurgical specifications and manufacturing standards for Red Wabbler rolls which will meet your requirements.

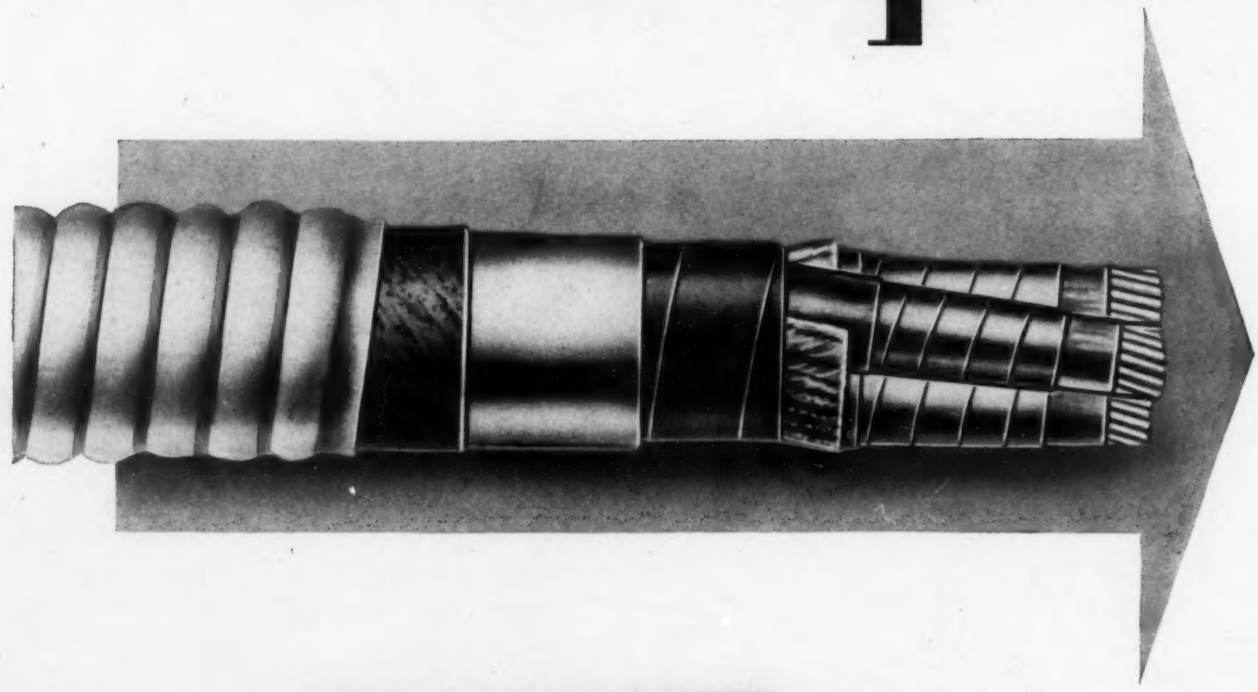
Production rolling of metals depends on the skill of the operator *and* the knowledge and facilities of the roll manufacturer. You understand your rolling operations—Mackintosh-Hemphill engineers know the metallurgical and manufacturing angles. Working together, we can make quick work of your production rolling problems.

MACKINTOSH-HEMPHILL CO.

PITTSBURGH & MIDLAND, PENNSYLVANIA

Makers of the rolls with the red wabblers

headed for a hot spot



THERE'S A DELTABESTON* HEAT-RESISTANT CABLE TO MEET CONDITIONS IN YOUR PLANT

Here's a multiple-conductor cable that has solved its own housing problem. Specially designed to meet unusual conditions of temperature and humidity in a large industrial plant, its highly resistant lead sheath is encased in an interlocking steel armor which serves as a conduit for the cable. It was built to be tough and, at the same time, to maintain the safety factor so necessary for plant efficiency.

Deltabeston cables have proved their worth through years of practical service on heat-resistant jobs in G-E plants and products. And this *usage-experience* can prove valuable in helping to solve your own cable problems.

If you're looking for the extra assurance of dependability and service that Deltabeston can give—or if you need a special heat-resistant cable such as the one pictured here to do a particular job, your Deltabeston distributor is ready to help you meet these specifications and to provide advice that will forestall emergencies.

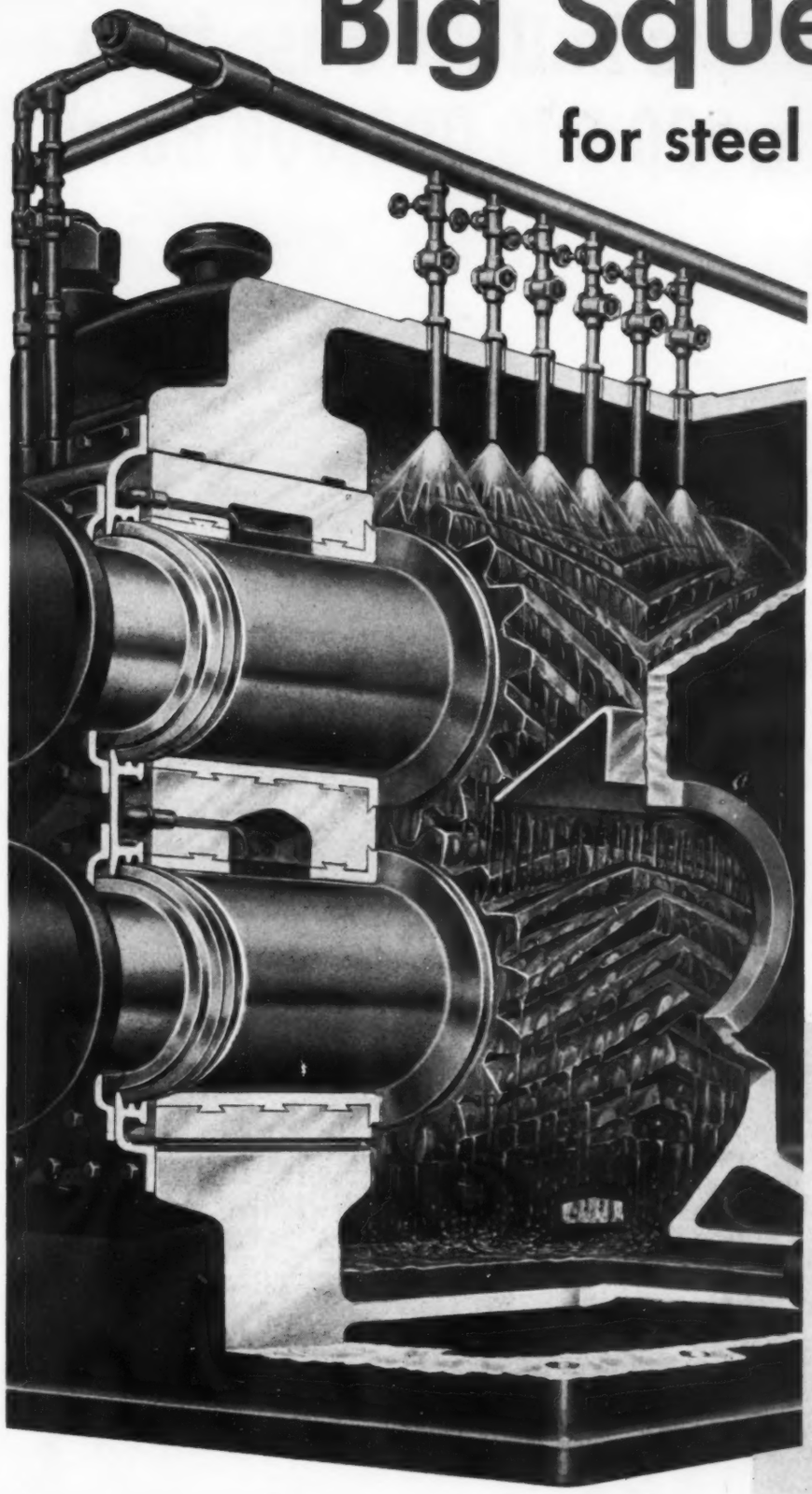
For a copy of the Deltabeston Cable catalog, write Section Y17-1131, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut. Deltabeston Wires and Cables are distributed by General Electric Merchandise Distributors.

*Trade-mark Reg. U.S. Pat. Off.

GENERAL ELECTRIC

Big Squeeze

for steel and oil, too!



IN THIS PINION stand, the tremendous pressures that squeeze massive ingots of steel into sheets or structural shapes, are actually transmitted through microscopic films of oil. Clinging to the meshing teeth, these films must resist rupture and prevent metal-to-metal contact, excessive friction, heat and wear.

To stand up under such exceptional conditions, "Prescription Lubricants" are required — Gargoyle Compounds. These Compounds form tough, tenacious films that will not be "squeezed out" or ruptured by the terrific pressures encountered in enclosed high-duty gears. Their rich lubricating qualities minimize wear and friction losses. Equally important in circulation systems, they resist deterioration in continuous use and assure low oil consumption.

For greatest protection . . . for longer gear life . . . for low maintenance costs, put Gargoyle Compounds in your pinion stands.

Get this Complete Lubrication Program for all your machines

- Lubrication Study of Your Entire Plant
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- Skilled Engineering Counsel
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GARGOYLE Lubricants

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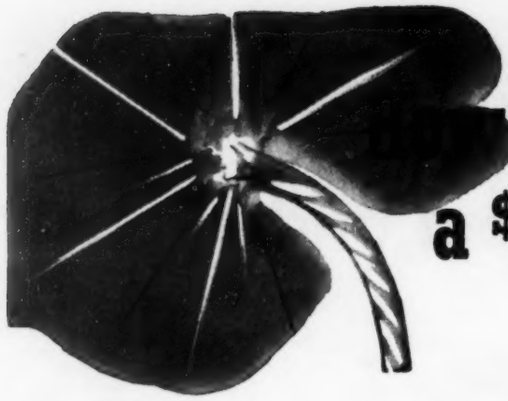
TUNE IN THE MOBILGAS PROGRAM — MONDAY EVENINGS — 9-30 E.S.T. — NBC



to Pull the Fuse from a $20,000,000,000 Bomb

IMAGINE a super bomb whose explosion could rock the entire nation. Such a bomb EXISTS—*but you can help render it harmless.*

This bomb is $20,000,000,000 surplus national income.

Authorities estimate that this year's total income will be $155,000,000,000—personal taxes will total $15,000-000,000—consumer goods and services will absorb no more than $120,000,000,000. This leaves $20,000,000,000. Even if banks and insurance companies absorb one-fifth of the surplus (as they did in 1945), there will still remain $16,000,000,000 that could be used to bid up prices.

You're doing yourself, your company, and your country a favor by continuing your payroll deduction plan for the regular purchase of U. S. Savings Bonds. At maturity, they pay $4 for every $3 invested!

THE PEACETIME PAYROLL SAVINGS PLAN—

A booklet, published for key executives by the Treasury Department, containing helpful suggestions on the conduct of your payroll savings plan for U. S. Savings Bonds.

THIS TIME IT'S FOR YOU

A booklet for employees . . . explaining graphically how the payroll savings plan works . . . goals to save for, and how to reach them with Savings Bonds.

Are you using these booklets?

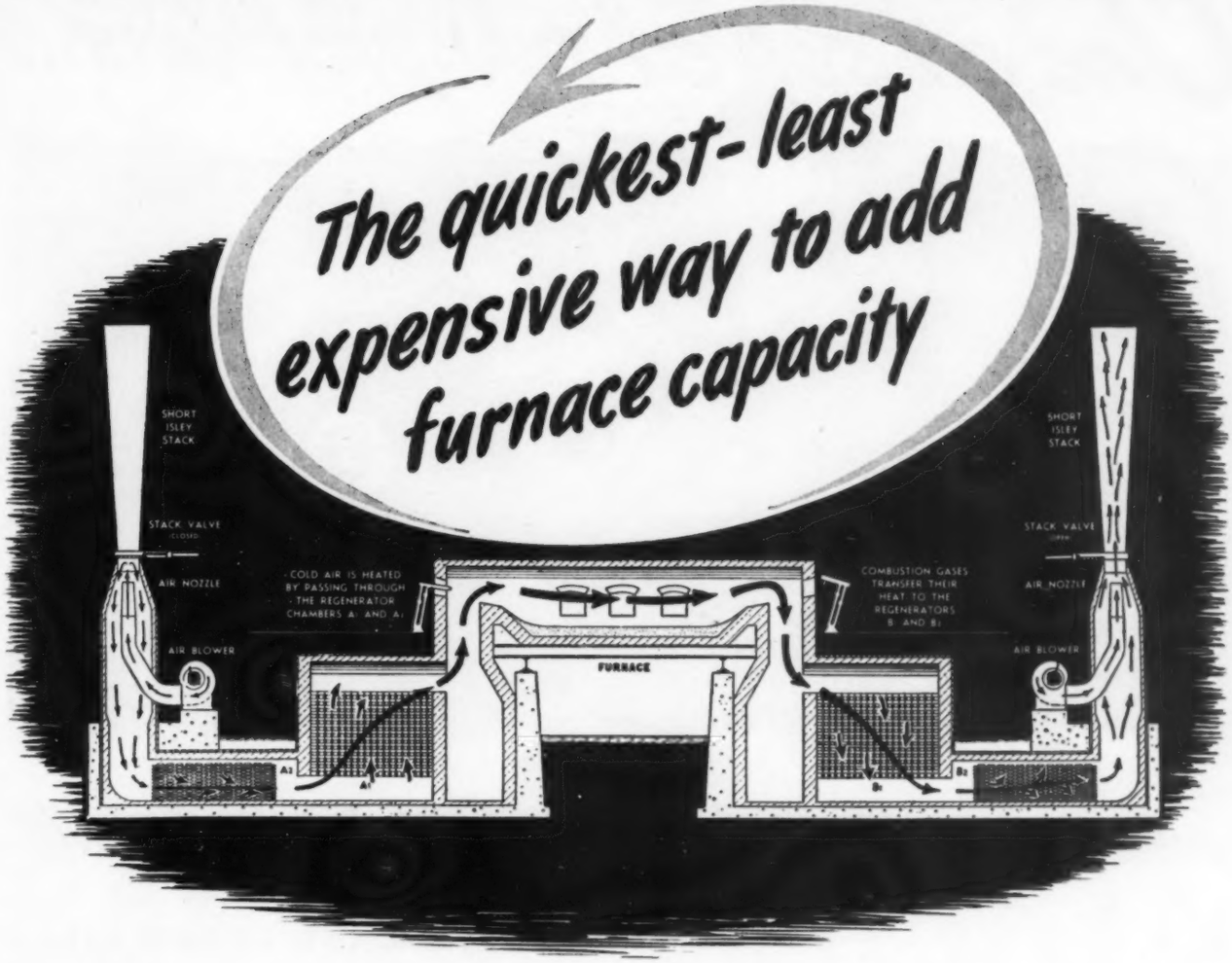
If not, or if you want additional copies, just ask your State Director of the Treasury Department Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

IRON AND STEEL ENGINEER

This is an Official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council

Isley Furnace Control System


The quickest-least expensive way to add furnace capacity
SHORT ISLEY STACK
STACK VALVE (CLOSED)
AIR NOZZLE
AIR BLOWER
COLD AIR IS HEATED BY PASSING THROUGH THE REGENERATOR CHAMBERS A1 AND A2
FURNACE
COMBUSTION GASES TRANSFER THEIR HEAT TO THE REGENERATORS B1 AND B2
SHORT ISLEY STACK
STACK VALVE (OPEN)
AIR NOZZLE
AIR BLOWER

THE Isley Control System *pulls out* the products of combustion and *pushes in* the air for combustion . . . gets more fuel burned per hour . . . produces faster heats with higher furnace temperatures . . . permits increased regenerative capacity for better recovery of heat.

Why build expensive stacks and foundations when an Isley System costs less, does a better job and pays for itself out of savings?

Write today for details. Give as much information as possible about your problem so we may reply promptly and completely.

Morgan Construction Company

WORCESTER, MASS.

Pittsburgh, Pa., 2815 Koppers Bldg.

MORGAN WORCESTER

ISLEY *Positive* Control

English Representative . . . International Construction Co., 56 Kingsway, London W. C. 2, England

CCC-4

One oil solved two problems...

when we switched to Tycol dual-purpose oils

FOR CUTTING AND LUBRICATION

"Stepped up machining speed 14% . . .
Increased tool life 3 times . . .
Jumped production 25% . . .
Improved finishes . . .
Excellent machine lubricant . . ."

— is how the superintendent of a large manufacturing plant described a few of the advantages of Tycol Dual-Purpose Oil. "As a matter of fact," he said, "this oil *not only* does the work of *two* separate cutting and lubricating oils — but does it *better*"!

For complete data on Tycol "Dual-Purpose," get in touch with your nearest Tide Water Associated office today.

LUBRICATION — "ENGINEERED TO FIT THE JOB"

TYCOL
INDUSTRIAL LUBRICANTS

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TIDE WATER ASSOCIATED OIL COMPANY
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Tide Water Oil Company of Canada, Ltd. • Toronto, Montreal

DON'T BUY

SO MANY DIFFERENT TYPES OF

CARBON BRUSHES

IT'S A FACT—you don't *need* to buy so many different types and sizes of motor and generator brushes! This has been established by surveys in various plants! A large steel company, for instance, discovered it could cut its brush items from 675 to 93. Another firm eliminated 2285 "necessary" brush sizes and shapes at substantial savings in ordering, billing, and in inventories.

Sponsored by National Carbon Company, Inc., this program of simplification of carbon, graphite, and metal-graphite brush needs can bring similar savings to you.

By making a few simple changes in present brush specifications, a comparatively few standard brush types and sizes will fill most of your varied needs.

HOW BRUSH SIMPLIFICATION PAYS:

1. Price advantage through quantity discounts.

2. Less money and space tied up in brush stocks.

3. Less time needed to handle stock.

4. Reduction of small orders—saving time in bookkeeping, billing, and accounting.

For further facts, get in touch with our nearest Division Office today. Dept. IS.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation
The word "National" is a registered trade-mark of National Carbon Company, Inc.

UCC

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are achieved through
FREYN DESIGN
Plus
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Whether Blast Furnace, Open Hearth, Rolling Mill, Power Station or auxiliary facility, the skill and experience of the Freyn organization, supplementing the knowledge of your own personnel, will assure the successful execution of the project.

The record is the proof.

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ASSOCIATED WITH
ASHMORE, BENSON, PEASE & CO. LTD., STOCKTON-ON-TEES, ENGLAND.

One Man--- One Minute...

Thats All it Takes to Bleed Wagner Hydraulic Industrial Braking Systems

Remote-control bleeding is the latest improvement in Wagner hydraulic braking systems for overhead traveling cranes and other industrial equipment. Controlled from the crane cab, the bleeder enables the operator to remove air from the fluid lines whenever necessary, simply by pressing a pushbutton and pumping the control cylinder foot pedal.

Other Advantages of the Remote-Control Bleeder:

1. One man can quickly bleed system.

2. Maximum braking efficiency is constantly maintained by keeping lines full of fluid at all times.

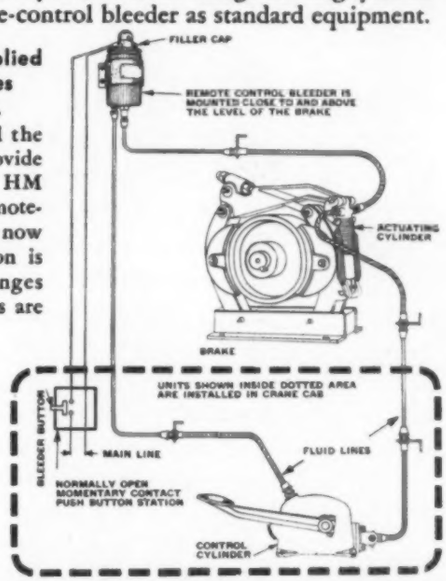
3. Circulatory bleeding results in a saving of fluid, since none is lost during the bleeding operation.

4. Brake can be installed at a considerable height above the control cylinder—an important factor in successful ladle crane applications.

All current Wagner Hydraulic crane-bridge braking systems include the remote-control bleeder as standard equipment.

Can Be Easily Applied to Wagner Brakes Now In Service.

Kits containing all the parts needed to provide type H and type HM brakes with the remote-control bleeder are now available. Installation is simple, as no changes in the basic systems are necessary.


FILLER CAP
REMOTE CONTROL BLEEDER IS MOUNTED CLOSE TO AND ABOVE THE LEVEL OF THE BRAKE
ACTUATING CYLINDER
BRAKE
UNITS SHOWN INSIDE DOTTED AREA ARE INSTALLED IN CRANE CAB
BLEEDER BUTTON
MAIN LINE
FLUID LINES
NORMALLY OPEN MOMENTARY CONTACT PUSH BUTTON STATION
CONTROL CYLINDER

In addition to these important features furnished by the remote-control bleeder, Wagner hydraulic industrial brakes offer many other advantages, discussed in Bulletin IU-186. Send for a copy today, addressing your request to Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo.

Consult Wagner Engineers on all Industrial Braking Problems

Wagner — LOCKHEED HYDRAULIC BRAKE PARTS and FLUID...NoRol...CoMaX BRAKE LINING

WE Electric — AIR BRAKES...TACHOGRAPHS...INDUSTRIAL BRAKES...ELECTRIC MOTORS...TRANSFORMERS

146-4

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In Canada: WAGNER ELECTRIC AT LEASIDE, ONTARIO

'Surface' OIL-FIRED

Modern, One-Way Fired, Recuperative Type featuring control of temperature and combustion to give all the engineering and operating advantages offered in the popular 'Surface' One-Way Gas-Fired Pits.

'Surface' engineered and built its first oil-fired pits in 1934. Since that date there has been a total of 80 'Surface' oil, oil-gas, or oil-tar fired pits installed in plants of leading steel producers.

These 'Surface' Oil-Fired Pits have lowered operating costs . . . solved seasonal fuel problems, or partial capacity operation, and made fuel storage possible, where such problems were of great importance to the operator.

Again, 'Surface' has proved ability to meet industry's needs by providing equipment to accomplish a desired result. This flexibility in equipment application has simplified operation and lowered production costs for operators.

In addition to one-way fired soaking pits, 'Surface' has a complete line of heating and heat treating equipment including slab heating furnaces—billet reheating furnaces—continuous heat treating furnaces for plate—continuous strip annealers and normalizers—pit-type convection furnaces for annealing rod, wire or strip in coils, high alloy rod and bar, atmosphere annealing furnaces of car-bottom lift-cover type—bright annealing and normalizing furnaces for tubing—stress relief furnaces—wire patenting furnaces—annealing covers, and the foremost equipment in prepared atmosphere generators for practically every heat treating operation.

It will pay you to discuss your heating and heat treating problems with a 'Surface' engineer.

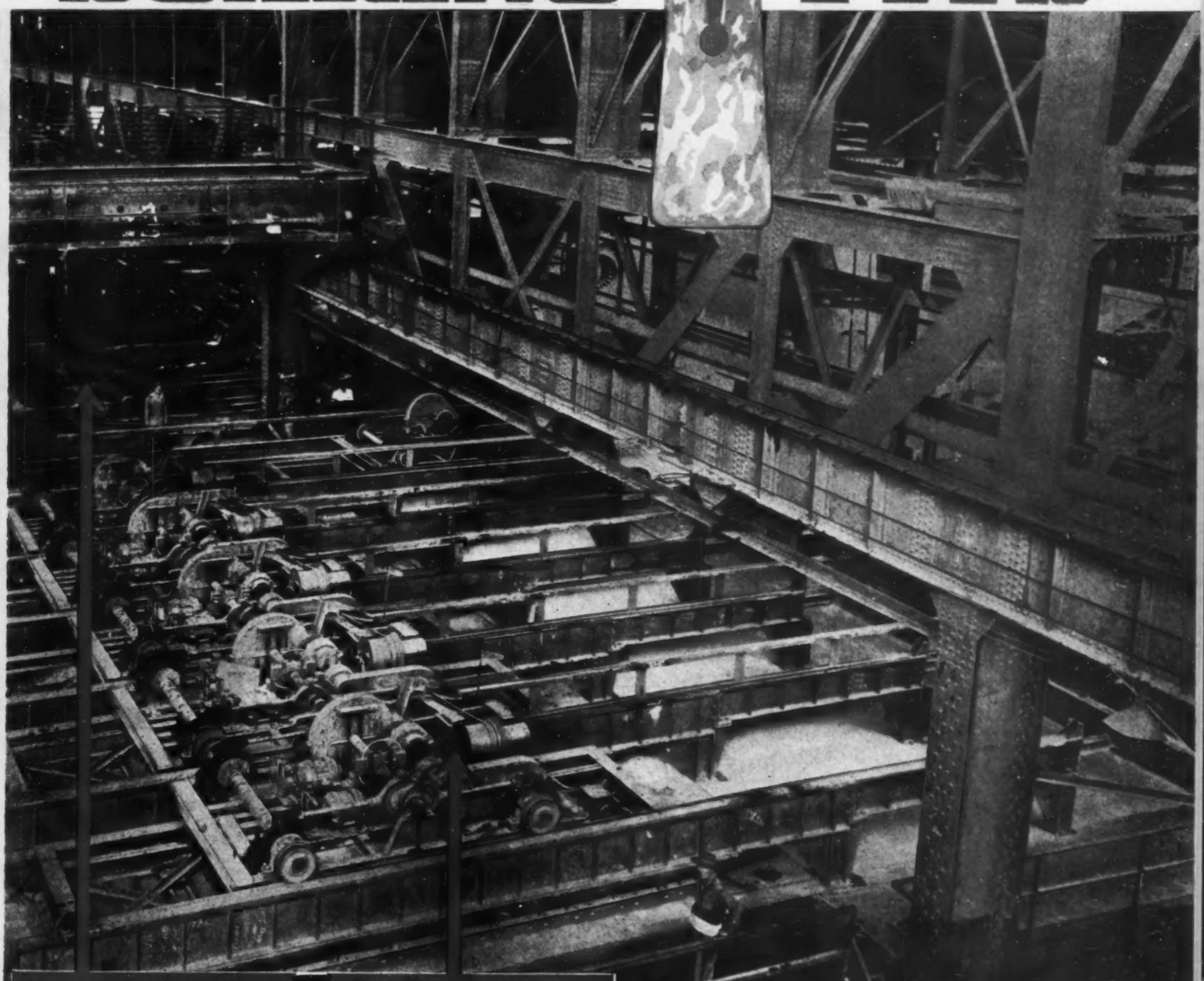
Above: A most rece 'Surface' Oil-Gas On Way Fired Soaking I installation at Cia Fun dore de Fierro, Monterr Mexico.

'Surface'

SURFACE COMBUSTION CORPORATION

TOLEDO 1, OHIO

SOAKING PITS

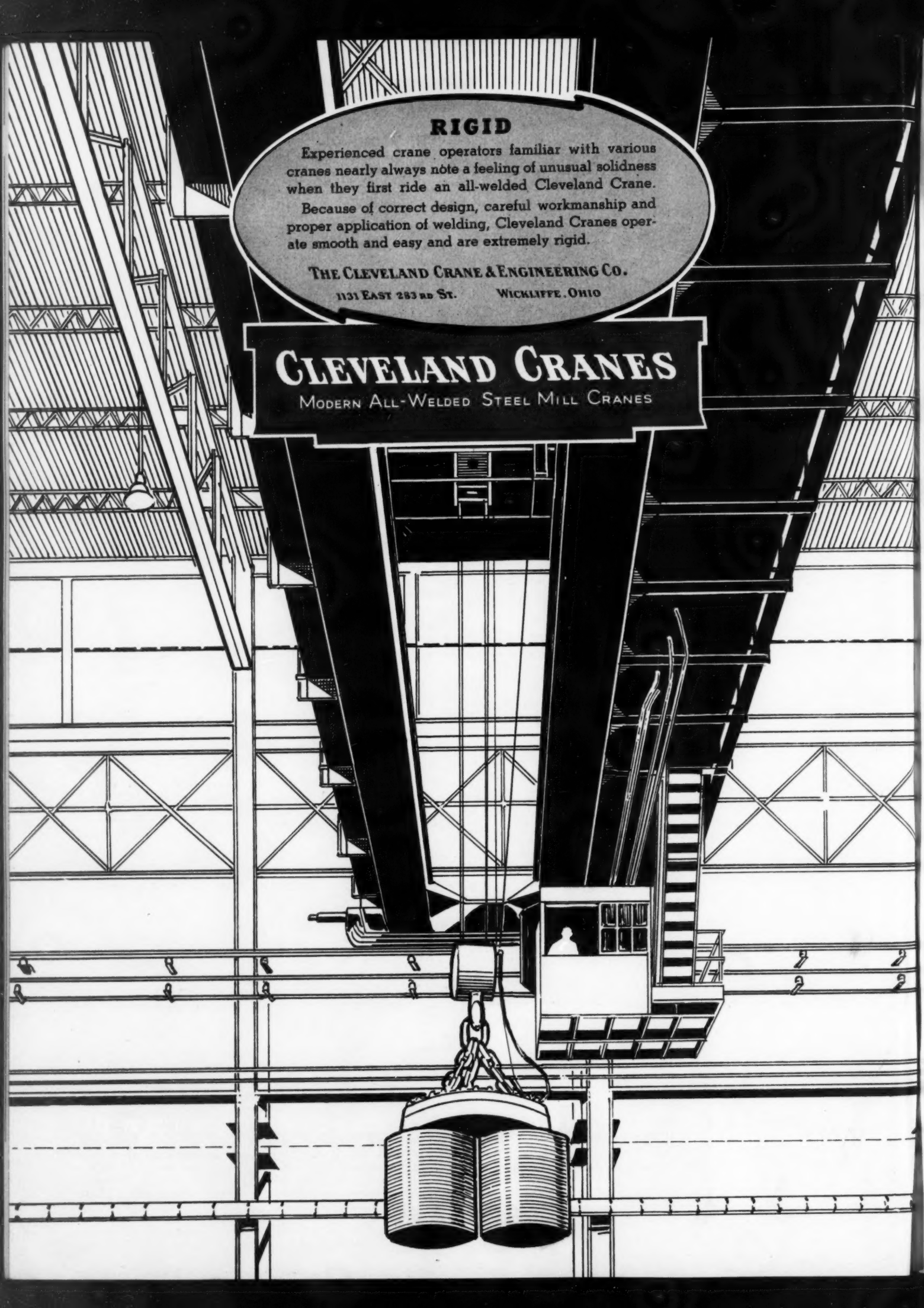


6
REGENERATIVE TYPE PITS WITH TOTAL CAPACITY OF
36 INGOTS
GAS-FIRED *ONLY*

6
'SURFACE' ONE-WAY FIRED PITS WITH TOTAL CAPACITY OF
84 INGOTS
OIL-GAS FIRED

'Surface' Increased Installed Capacity 133%

← In the foreground the above photograph, the battery of six 'Surface' One-Way Oil-Gas Fired Soaking Pits has a total installed capacity, under the service of the pit crane, of 84 — 22 in. x 24 in. ingots. In the background of the same photograph is shown six regenerative type pits with a total installed capacity of only 36 ingots. Therefore, in the same size area, between the building columns, 'Surface' has provided an *increased installed capacity of 48 ingots.*


RIGID
Experienced crane operators familiar with various cranes nearly always note a feeling of unusual solidness when they first ride an all-welded Cleveland Crane.
Because of correct design, careful workmanship and proper application of welding, Cleveland Cranes operate smooth and easy and are extremely rigid.
THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 283 RD ST. WICKLIFFE, OHIO
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

SUGGESTIONS have recently come from labor organizations that school books should be rewritten so as to give labor a better break. A recent letter to the editor of a Chicago paper suggests that we start with the dictionary, inserting the following definitions:

Labor union: a group associated together to secure by force advantages and privileges that are not enjoyed by any other citizens.

Strike: an attack on the employer to secure money or other advantages in which the public is held as hostage and inconvenienced by lack of conveyances, communications, food, electricity, fuel, clothes, heat, and luxuries.

Peaceful picketing: legalized mayhem, murder, and property destruction.

Slowdown: doing what comes naturally and taking it easy.

Sitdown: doing even less.

Scab: any one who wants to work.

Contract: an agreement that is good for about six months and is binding only on the employer.

▲

THOSE of us who are still in the steel business three or four years from now can celebrate the making of the two-billionth ton of steel produced in the United States during this century. Figures from the American Iron and Steel Institute show nearly 1,910,000,000 net tons of ingots from January, 1901 through August, 1946. Striking is the fact that almost one-third of this amount was produced since the beginning of 1938.

▲

THERE seems to be an epidemic of "open houses" being held by the various steel producers for workers' families and the local communities in general. While it is true that men generally take pride in explaining their job to the "little woman," a lot of those men aren't going to be able to get away with their claims to total exhaustion when they come home from work in the future.

▲

ALTHOUGH it isn't exactly news, Philip Murray, CIO president, has announced that the United Steelworkers will demand a substantial wage increase as soon as possible. Mr. Murray stated: "American industry is making sufficient profit to pay a very healthy increase to labor without increasing the cost of living." Perhaps Mr. Murray has a system of accounting of his own — one that calls for turning over the entire remaining profit to labor. Then his statement might have a semblance of truth. Of course, the stockholders can starve.

▲

CONTINUING this train of thought, we wonder if automotive labor wants their wage increase to come out of profits. Compared to 1941, employment in the automotive field is up 25 per cent, weekly payrolls are up 76 per cent, and production is down 40 per cent. If this continues, our mass production pioneer industry will be priced right out of the mass market.

▲

WITH the meat shortage disappearing, gravy spots again resume their status as a sign of sloppiness instead of a mark of distinction — but if meat prices keep up they may become a sign of affluence.

▲

AND speaking of prices, if they keep on rising, the old phrase "dollars to doughnuts" will be an even bet.

▲

SOME retrenchment is to be observed in various manufacturing industries. This is in many cases simply an elimination of careless spending which developed during wartime, but there are also some cases rising from the results of surveys of sources of raw material and component parts, with reductions in line with expected production rates as indicated by the material supply.

▲

SPEAKING before the National Association of Sheet Metal Distributors, R. M. Nelson of American Rolling Mill Company stated that facilities now under construction will add 3,000,000 tons to the annual capacity for sheet and strip, which is expected to rise to 19,000,000 tons.

▲

WE know a salesman who always keeps his hat on while working at his office desk. He says it's to remind him that he has no business being there.

▲

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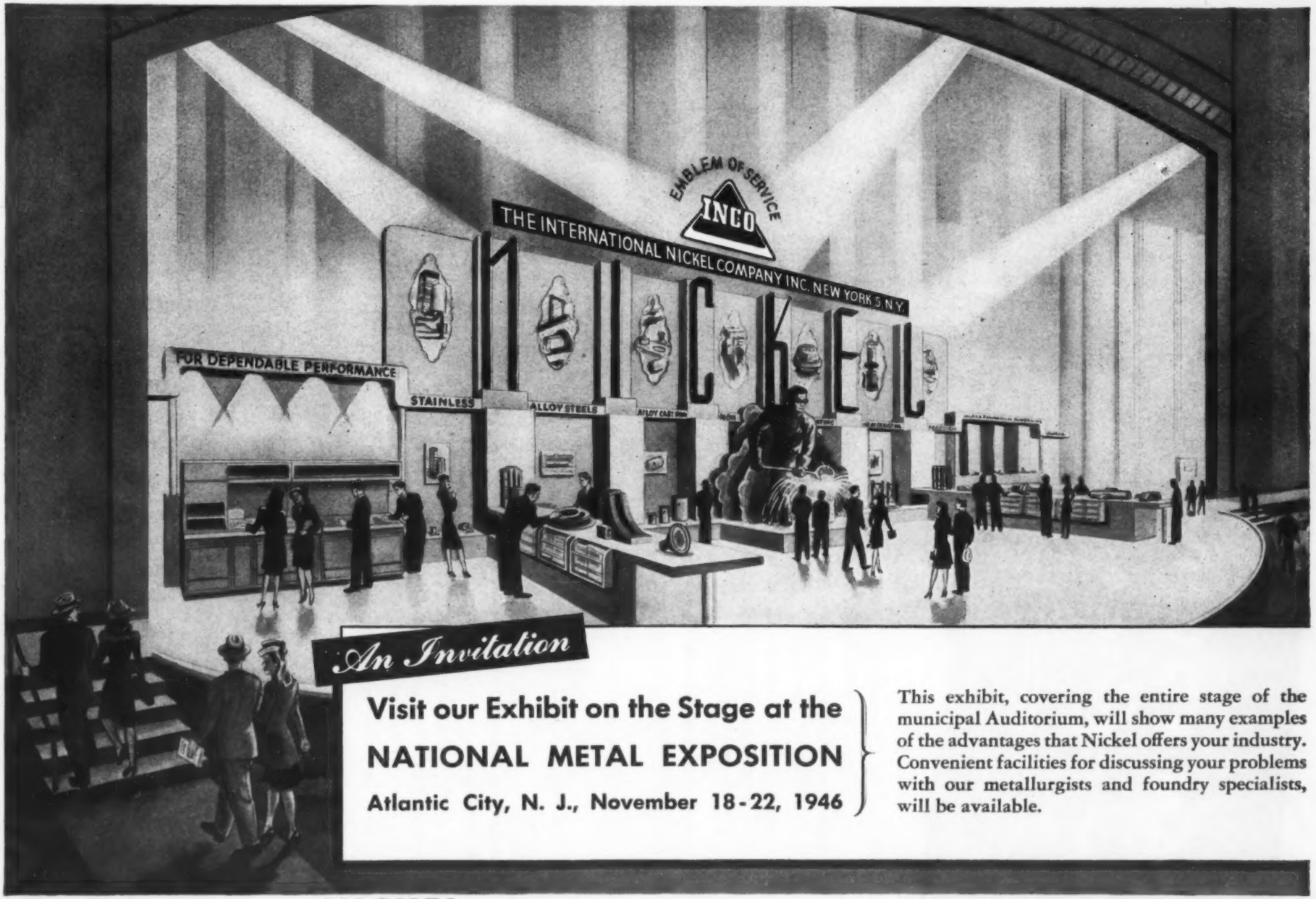
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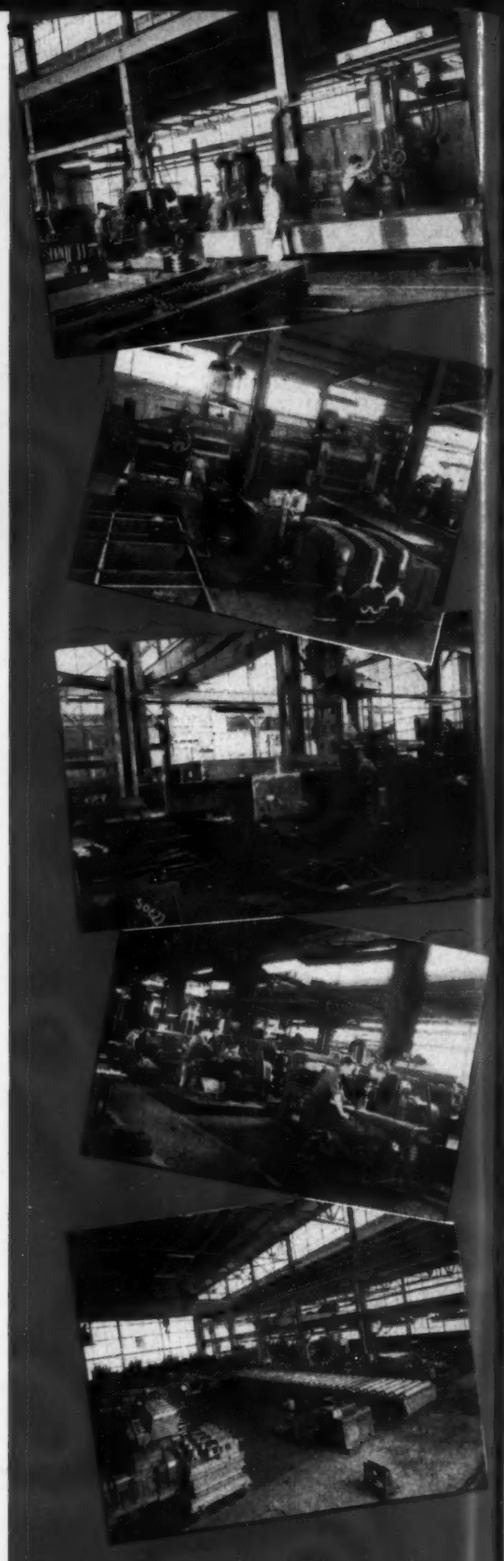

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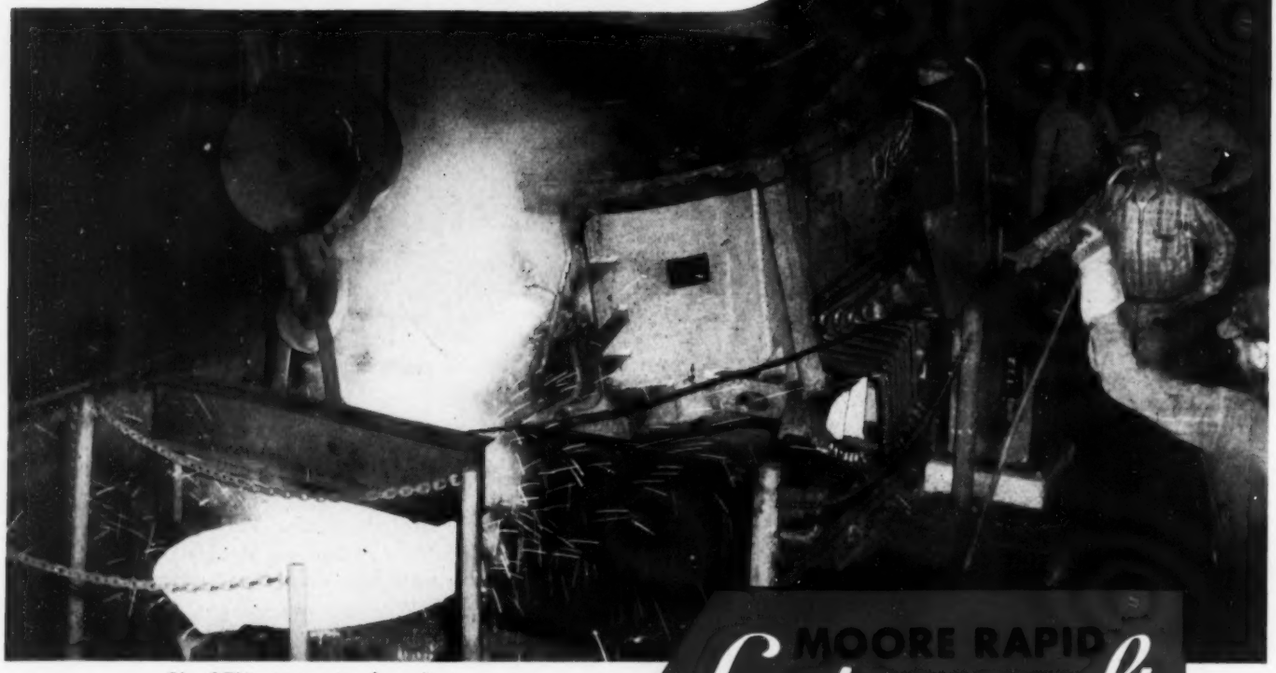

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Arc Furnace Switching

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by L. W. Long and *J. F. Chipman*

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▲ THE selection and maintenance of electric arc furnace switching devices are among the more important problems confronting the arc furnace operators today. During the busy war years, the maintenance required by the furnace switching devices on some installations was a very appreciable factor in arc furnace production schedules.

The postwar period will, no doubt, see keen competition between ferrous and non-ferrous metals. The cost of the operation and maintenance of the electric arc furnace for producing high alloy steels cannot be neglected in evaluating ways and means of producing steel at lower costs. The maintenance of arc furnace switching devices may constitute an important item and, therefore, must receive due consideration.

The duty on an arc furnace circuit breaker differs markedly in several respects from that on the usual power circuit breaker application. On the usual circuit breaker application, the circuit breaker is primarily a protective device. It operates infrequently to interrupt short circuits, and is also used, sometimes as often as twice a day, for load switching.

The arc furnace circuit breaker is primarily a switching device. It operates even less frequently than a power circuit breaker on short circuit, but about 100 times as frequently on load switching service. In addition, on some installations, the arc furnace circuit breaker is subjected to severe switching voltage surges.

Because of these peculiar requirements of arc furnace switching, special consideration should be given to the selection and maintenance of arc furnace switching devices.

The arc furnace art is not old, but marked advancements have been made in arc furnace metallurgy with a resultant marked increase in the number and size of arc furnace installations. The first arc furnace was small, and was operated with relatively low transformer primary voltage, and at a single fixed low furnace supply voltage. The furnace controls were simple, and standard conventional switching devices were used. With progress in the arc furnace art came larger furnaces and more complex heat cycles involving a multiplicity of furnace voltage and reactance taps, and demands for closer furnace arc energy regulation, thus requiring more complex control and greatly increasing the number and frequency of the operations of the switching device, since it is operated for each tap change.

At the same time, overall increases in steel mill power consumption resulted in increased mill generator capacity, and increases in the capacity of interconnections with the power companies, with a resultant increase in the short circuit capacity of the power supply circuits to many furnace installations. Where the furnace switching devices, usually oil circuit breakers, were arranged to provide primary short circuit protection, their size and rating increased correspondingly.

With continued increase in mill power capacity, the primary mill power supply voltages have increased in many cases to 22 kv, 33 kv, and even 46 kv, which voltage is usually applied directly to the furnace transformer primary and, therefore, determines the service voltage at which the furnace switching device operates, as indicated in Figure 1. Most of the larger furnaces, that is, the 50 to 70-ton units, are supplied from 22 kv systems. There are several 33 kv installations of small, as well as large, furnaces.

The arc furnace switching breaker is installed on the primary side of the furnace transformer, and on the usual installation is required to provide primary short circuit protection. The circuit breaker is operated at the start and end of each heat, and also for each tap

Presented before Cleveland Session of the Annual AISE Meeting, October 3, 1945.

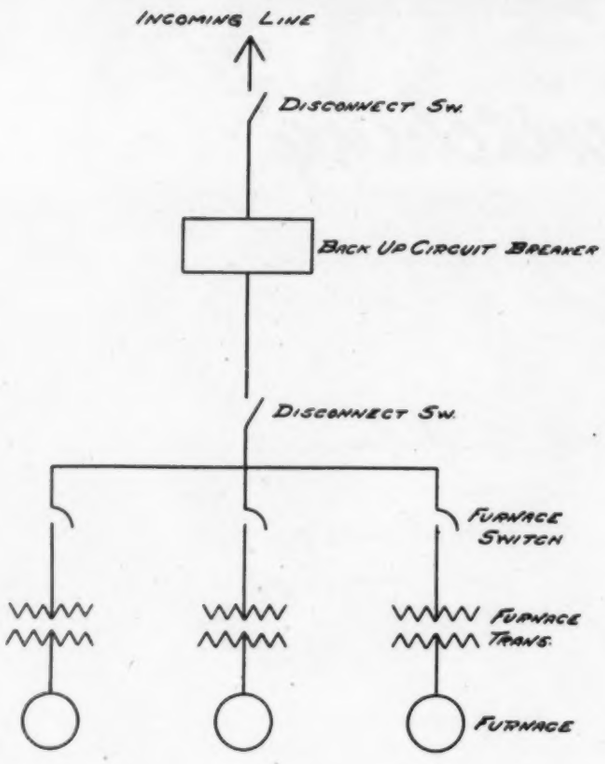


Figure 1 — Typical arc furnace diagram.

change during each heat. Since the majority of such breakers are automatic, they may also operate several times during a heat on overload, and on some installations on power demand. The result is that arc furnace circuit breakers are operated from 40 to 100 times a day on steel furnaces, and on some special and nonferrous furnaces as many as 200 times a day.

The majority of the furnace switching devices in service are oil circuit breakers, and were selected of suitable interrupting rating to provide primary short circuit protection. They range in size from the 5 kv, 50,000 kva common tank indoor circuit breaker to the 46 kv, 500,000 kva, tank-per-pole outdoor circuit breakers. Since they are designed primarily for short circuit protection and for only infrequent switching operation, many standard circuit breakers are not particularly well suited to withstand the wear and tear of large numbers of switching operations.

In an oil circuit breaker, the oil is used as the interrupting medium and also as an insulating medium. While the arc energy expended on the oil in a modern oil breaker on a single furnace switching operation is small, the cumulative effect on the oil in a circuit breaker tank of thousands of such switching operations is considerable, particularly if the oil volume is small. Breaker size and efficiency, oil volume, the furnace size, and the number of switching operations are all factors in determining the rate of oil contamination.

If the function of furnace switching itself were the only consideration, the breaker oil might be used without particular regard to the degree of contamination. However, the breaker must continue to withstand the line voltage and switching over-voltages and, in most cases, be ready at all times to provide short circuit protection. As the oil becomes contaminated, the insulation level of the breaker tends to be lowered by the presence and deposits of carbon around and on the interior insulating surfaces, and the interrupting ability of the breaker may also be impaired.

Therefore, from a dielectric point of view, many arc furnace applications are more severe than most standard breaker applications, because of the combination of the higher rate of insulation impairment, both internal due to oil carbonization and external due to steel mill ambient conditions, and because of the severe switching surges resulting from certain furnace circuit configurations. For a discussion of this latter subject, we refer you to the Hodtum-Rice AIEE Paper No. 43-97, dated May 1943, and also a paper entitled "Voltage Transients in Arc Furnace Circuits," AIEE Paper No. 44-99 dated May 1944, which is a report by the AIEE Committee on Electro Chemistry and Electro Metallurgy.

For a number of years, we have given special consideration to circuit breakers for electric arc furnace switching application. Where feasible, particularly on the larger oil circuit breakers intended for furnace duty, special mechanical features have been incorporated to provide for the much greater mechanical duty. We have consistently recommended the use of circuit breakers having an insulation level one step higher than that normally required for the particular service voltage to combat the conditions of insulation contamination and voltage transients. We have also recommended the use of circuit breakers having a substantial oil volume, which makes for a lower rate of oil contamination and less frequent oil maintenance. All of these practices have been proven sound.

Even the best possible circuit breaker application does not, of course, eliminate maintenance. It can only reduce the amount of maintenance, and the degree of operating hazard when the regular maintenance is unavoidably delayed.

An organized program of preventive maintenance of both mechanical and electrical details is required for any type of circuit breakers on any application. In the case of circuit breakers on electric arc furnace duty, the frequency of maintenance must of necessity be greater because of the more severe duty. In any case, the degree to which the circuit breaker oil and insulation surface contamination is allowed to progress must be limited in order to maintain the insulating and interrupting integrity of the breaker. It is very important that the liners, lift rods, guides, bushings, and other internal insulating surfaces be cleaned when the oil is reconditioned or replaced. All mechanical operating parts should be inspected and their fastenings checked. The contacts and interrupting devices should also be inspected.

The required frequency of preventive maintenance can best be established by experience under the particular conditions of application and operation. In the case of small oil breakers, particularly of the older types, relatively frequent maintenance is required. On the other hand, the large modern repetitive duty oil circuit breakers used on the higher voltage applications

usually require only relatively infrequent maintenance.

While the performance of modern repetitive duty oil circuit breakers as arc furnace switching devices has been good when the breakers have been properly applied and maintained, it appeared that here too improvement might be made, and that a type of device might be made available which would offer a minimum of maintenance and be applicable throughout the range of furnace supply voltages. In such a device, it seemed desirable to eliminate the oil maintenance, to use a minimum of contact and interrupting parts requiring maintenance, to keep the number and mass of moving parts low, and to provide a device in which all vital parts have long life, are easy of access, and are easy to service or replace.

Since furnace switching devices are actually very seldom required to interrupt a fault, it appeared feasible to provide fault protection for furnace circuits in groups. Each group of furnaces would be fed through a single circuit breaker of sufficiently high interrupting capacity to provide fault protection for the entire group, which would permit the individual furnace switching devices to be designed especially for their own peculiar, highly repetitive switching duty at relatively low currents.

There has been a trend towards oilless circuit breakers and switches for certain classes of industrial and power switching devices, especially in the lower voltages and capacities. Air magnetic breakers are being used to some extent for furnace switching at the lower voltages. They eliminate the oil and are somewhat easier of access than oil breakers.

The particular set of conditions involved in the furnace switch maintenance problem seemed to indicate that an air blast furnace switching breaker, particularly of the axial blast type designed especially for arc furnace duty, may well have distinct possibilities. The elimination of oil maintenance, the use of light but rugged moving parts, the ease of access to contacts, the ease of cleaning vital insulating surfaces, the use of the prestored energy of compressed air and the suitability for application throughout the range of furnace supply voltages all appeared to be desirable features.

Accordingly, air blast furnace switching devices especially designed for arc furnace duty at 22 kv and 15 kv were developed, exhaustively tested in the laboratory, and placed in service on typical arc furnace applications.

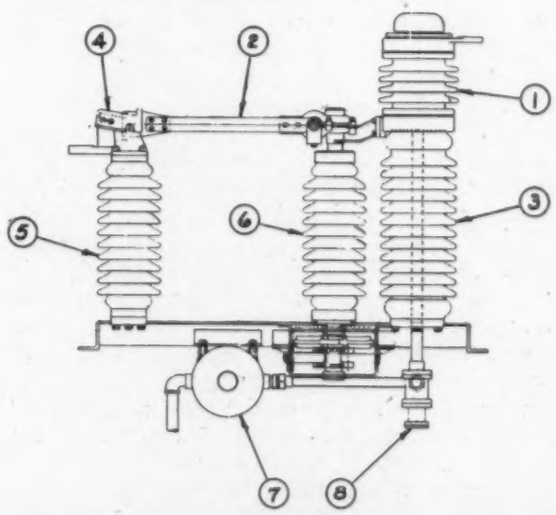
The carrying and interrupting current capacities required for switching devices which handle only arc furnace transformer magnetizing load and overload currents, including transformer secondary cable short circuits, are relatively small. A survey of the existing and projected installations indicated that for some time to come a maximum continuous load current carrying capacity of 600 amperes would be ample for the largest furnace installations at any primary voltage. Since the furnace transformer and series reactance limits the maximum primary current due to overload or secondary fault to 2 to 2½ times the normal maximum load current, a maximum interrupting rating of 1500 amperes would also be ample for the largest furnaces. These conditions permitted the use of inherently light movable contacts and concentration on interrupting characteristics in a relatively narrow low current range.

The ABF-2 arc furnace switching breaker was developed using the axial air blast principle for experimental installation at the higher voltages. It is rated 600 amperes carrying capacity, 600 amperes normal interrupting capacity, 1500 amperes maximum interrupting capacity, for application with group back-up protection on arc furnace switching duty at 23,000 volts. In keeping with our general practice on arc furnace application, the insulation level, phase spacing and isolator break distance of this device conform to NEMA Standards for the next higher class, namely, 34.5 kv, which also give the device physical proportions enabling it to be easily substituted for experimental operation in place of an existing oil circuit breaker.

Basically, the electrical circuit of this air blast switching breaker, Figure 2, consists of two sets of contacts in series, one set acting under a blast of compressed air to interrupt the circuit, the other pneumatically operated, providing isolation of the circuit after interruption. The interrupter contacts are located within a porcelain chamber (1) which, together with the hinged end of the isolator contact blade (2) is mounted on a hollow porcelain column (3). This column provides the compressed air feed to the interrupting chamber as well as insulation to ground. The laminated brush type stationary isolator contacts (4) are mounted on a second porcelain post insulator (5). A third and rotating insulator (6) provides for operation of the isolator arm through a gear box which forms its hinge. The blast air for interruption is controlled by a blast valve (8) which feeds the air from the manifold tank (7) up through the hollow post insulator (3) to the interrupting chamber (1).

The three columns per phase (1) are mounted on the top of a rectangular steel framework, shown in Figure 3, which encloses all of the pneumatic equipment necessary for operation, thus making the switch a self-contained unit. Directly under the insulator columns is mounted

Figure 2 — Pole unit of arc furnace interrupter switch showing primary electrical and air circuits.



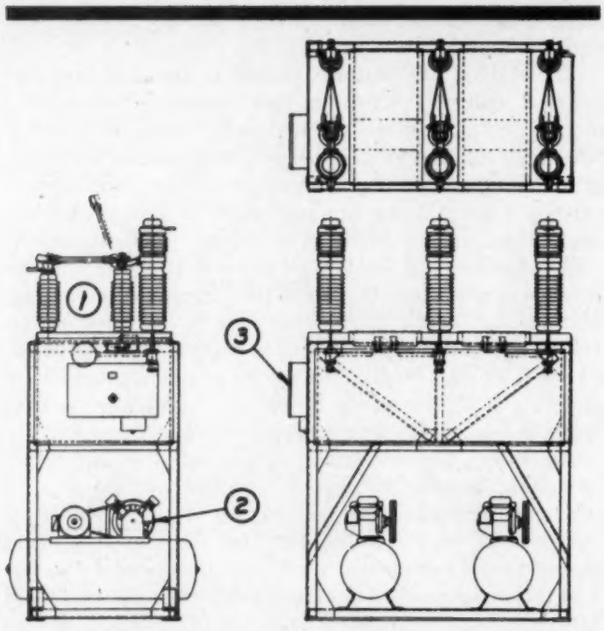


Figure 3 — This arc furnace interrupter switch is rated 23 kv, 600 amp carrying capacity and 1500 amp maximum interrupting capacity and has 34.5 kv insulation.

the pneumatic operator including the air cylinders, blast and control valves, and the piping and mechanical linkages between the three phase isolator units. Below in this arrangement, supported on the base frame, are two compressor units (2) with tanks for storage of compressed air. On the outside and at one end of the frame is located an easily accessible cabinet (3) which contains the electrical and pressure-operated relays and the auxiliary switches and wiring for control of this switching breaker.

The interrupting unit, see Figure 4, consists essentially of a high strength porcelain chamber enclosing the axial blast type interrupting element. The contacts are of the high pressure butt type reducing mass to a minimum. The stationary contact (2) is a tear-drop shaped unit located in the center of the air blast stream. The replaceable arcing tip is easily accessible. The movable contact (3), held in the closed position by springs, is guided at the top by the current transfer contact, and at the bottom by the piston against which air pressure acts to move the contact. Resilient bumpers limit the opening of the contact, and reclosing is gentle due to the characteristics of the pressure decay.

Interruption of the circuit is accomplished by opening the blast valve which releases compressed air to the interrupting chamber of Figure 4, where the build-up of pressure opens the arcing contacts, allowing air to flow between them, literally blasting out the arc. As the movable contact (3) parts from the stationary contacts (2), an arc is drawn between them. The motion of the movable contact opens an arcing orifice through which the compressed air expands into an insulated arcing chamber. The dynamic effect of the escaping air causes immediate transfer of the arc to the arc resistant tip of the stationary contact, and extends and centralizes the arc through the orifice until it reaches the auxiliary arcing contact (4). In this position, the arc is completely enveloped by rapidly flowing and expanding compressed air, with the result that the arc products are rapidly deionized by diffusion and cooling and the arc is extinguished at an early current zero. The axial air flow is carefully coordinated with the arc current characteristics to meet the particular conditions of arc furnace switching.

Since air continues to flow after current zero and the deionized arc products have been vented to atmosphere, restriking of the arc would have to occur at the point of minimum break distance, that is, between the main arcing contacts. At this point, however, the air has not been permitted to expand to any marked degree, and its dielectric strength is comparable to that of new insulating oil. This, plus the fact that the air is moving at high velocity, provides an insulating medium such that a comparatively short contact separation is sufficient to prevent restriking of the arc after current zero. This action is extremely rapid and is accomplished in a small chamber with a short stroke of arcing contacts and requires a relatively small quantity of air.

After interruption, the pneumatic cylinders operate to open the isolator contacts. The pneumatic interlocks cut off the air blast and the reset springs then reclose the interrupting contacts as the pressure level decays in the interrupting chamber. The isolator arms are positively positioned at the end of the stroke by over-toggle springs.

Since the interrupting contacts reclose after their function is completed, reestablishment of the circuit is accomplished by merely closing the isolator contacts. The isolator stationary brush contacts are protected by horns so located that the initiation of the circuit causes no burning on contact surfaces. Each rotating column is provided with a pneumatic brake which acts to absorb the energy of operation. Also, at the end of the closing stroke, the isolator blades register in full contact against resilient bumpers.

Control of this breaker by the operator is identical to the usual control for oil circuit breakers on similar duty. The pneumatic operation is controlled by low energy electrically-actuated solenoid valves. Adequate interlocks are provided in the pneumatic and electrical control systems to insure proper sequence of operation and to protect the switch against operation at subnormal air pressure. Alarm switches indicate the approach of such low pressure conditions. Hand operated valves, interlocked against low pressure, provide for operation in case of failure of the d-c control voltage. It is recommended that relaying be installed to prevent operation of the switch at current values in excess of its rating in case of primary short circuits between the switch and the furnace transformer.

Two automatically controlled compressors charge two tanks to about 175 psi, at which pressure they contain enough free air for about ten closing and opening operations before low pressure lockout. This insures completion of a furnace heat, should the power supply to the compressor motors fail during a run. The air is fed through a strainer and reducing valve to the switch manifold for use at 135 psi. The compressor units are so arranged that the two tanks can be fed from either or both compressors, thus providing the maximum reliability of air supply.

The first unit of this Type ABF-2 arc furnace switch-

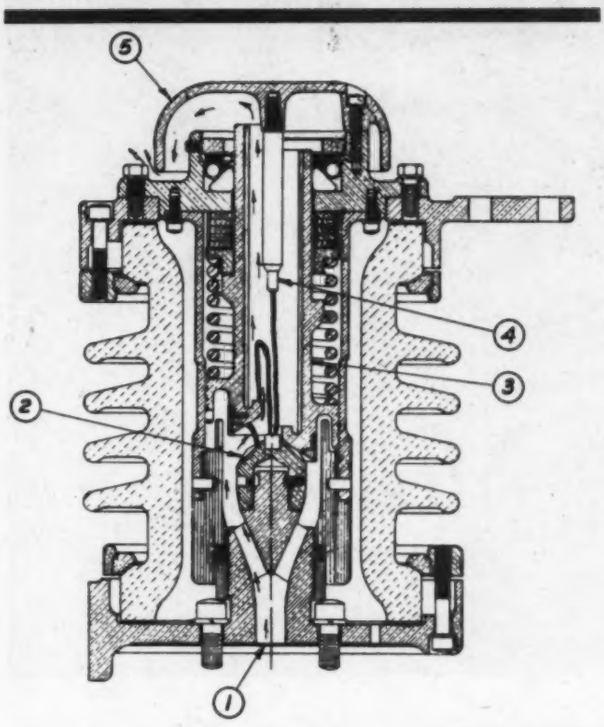


Figure 4 — In this sketch, the left half shows the movable contact in interrupting position and the right half in normal closed position.

ing breaker was subjected to an extensive series of laboratory tests, including timing, heat run, dielectric, mechanical life and interrupting tests.

A preliminary mechanical shakedown test of approximately 4,000 operations was run, during which minor alterations and adjustments were made. Subsequently, at about 5,000, 7,000, 10,000 and 16,000 operations, the switch was checked and a few adjustments changed. The test was then continued to about 27,500 operations without further alteration or adjustment, after which it was disassembled and checked for indications of excessive wear or yield of material. Since no major weak points were found, the switch was reassembled for interrupting tests.

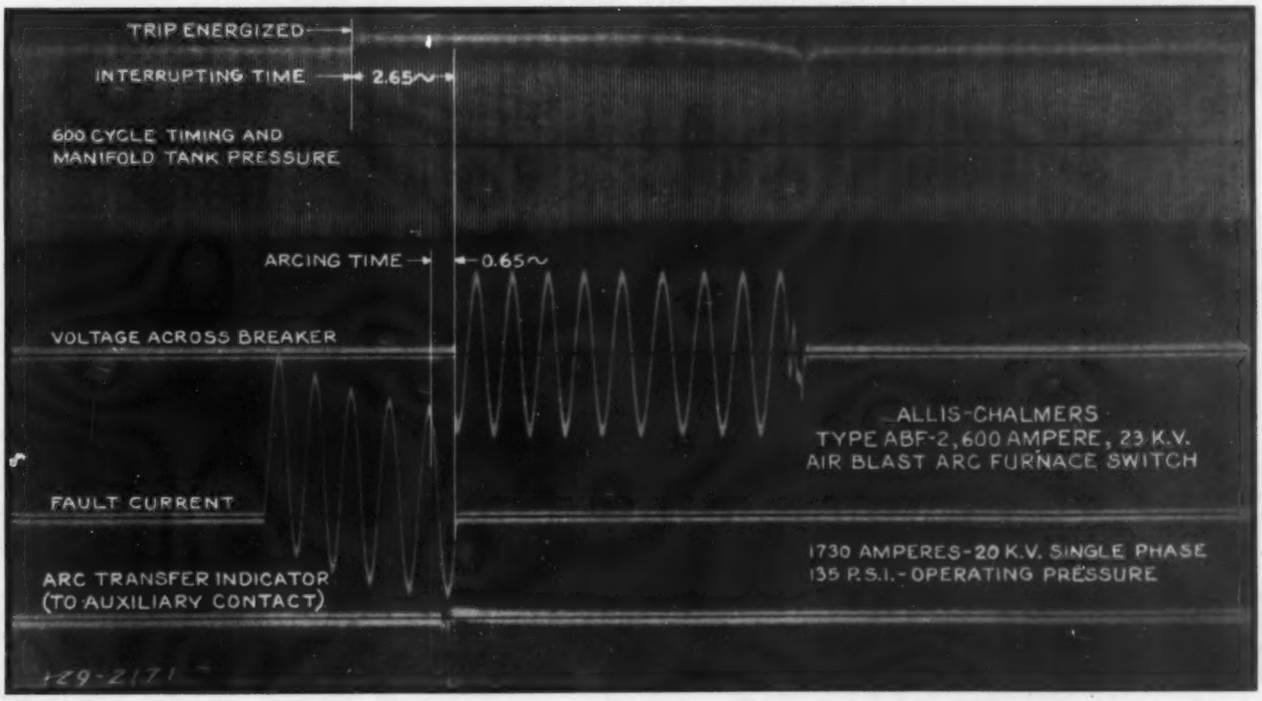
An extensive series of interrupting tests were then made up to current values in excess of its maximum interrupting rating. During these tests, the air blast flow characteristics and contact details were revised slightly as the need was indicated by test results. These tests were made single phase, 60 cycles, at 20,000 volts to ground.

Figure 5 is an oscillogram of one of these interrupting tests, made at 1730 amperes or 115 per cent of the maximum interrupting rating of the device. The total switching time from the energization of the trip coil to circuit interruption was 2.65 cycles, and the arcing time was 0.65 cycles. Figure 6 is a similar oscillogram at 435 amperes, or about 67 per cent of the normal interrupting rating of the switch. In this case, the mechanical time was 1.5 cycles and the arcing time was 0.45, making the total switching time 1.95 cycles. Consistently short interrupting time even at low currents is characteristic of air blast devices due to the use of the prestored energy of compressed air for interrupting the arc.

Following these interrupting tests, another series of mechanical operations was made bringing the final total of the mechanical operations on the same unit up to approximately 30,000.

Several years ago a Type ABF-2 furnace switching

Figure 5 — Typical interrupting test oscillogram on air blast interrupter switch at 1730 amp, 20 kv, single phase.



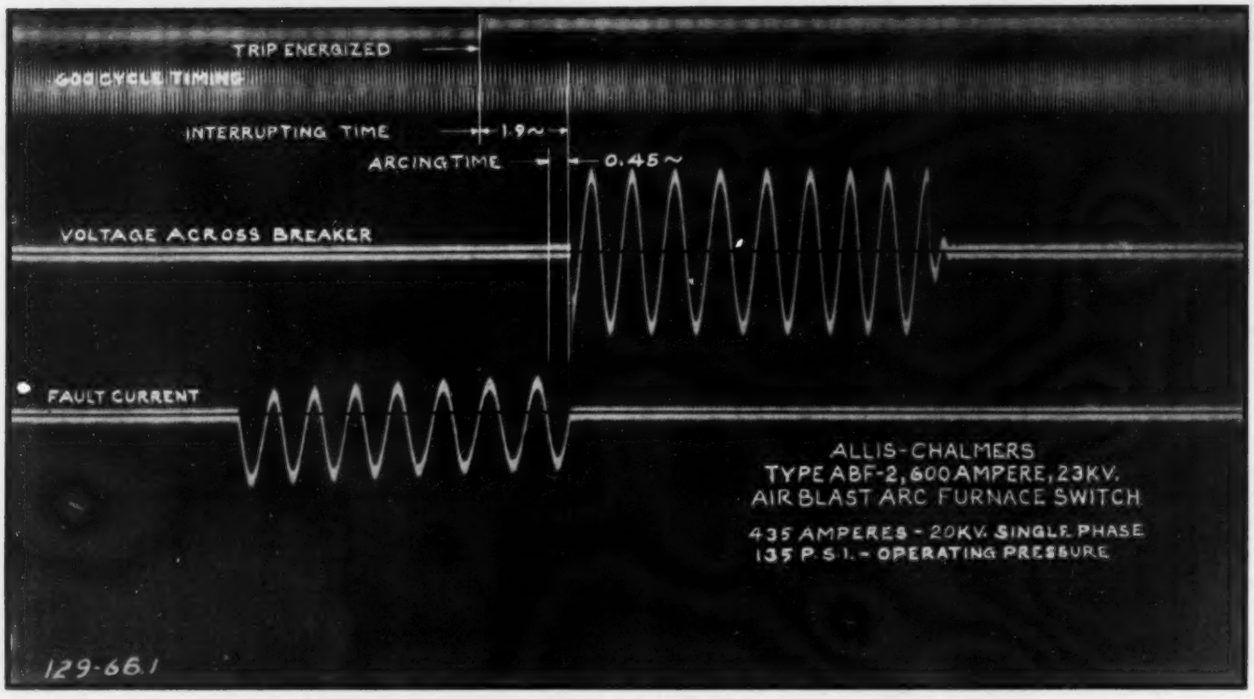


Figure 6 — Typical interrupting test oscillogram on air blast interrupter switch at 435 amp, 20 kv, single phase.

breaker, Figure 7, was installed by the Timken Roller Bearing Company in the 23.4 primary of a 12,000 kva, 3 phase, 60 cycle transformer supplying a 19-foot, 60-ton arc furnace. The full load current on this application is approximately 300 amperes and the 50 per cent total impedance limits the maximum switching duty in case of furnace cable fault to about 600 amperes. This, and another furnace circuit are fed through one backup breaker of 1,000,000 kva interrupting capacity. The air blast furnace switching breaker operates non-automatic, with the backup circuit breaker set to open on primary faults only. This air blast switching device is operating 50 to 60 times daily.

The ease and simplicity of maintenance of the air blast arc furnace circuit breaker is an outstanding feature. Visual inspection of the entire device and its auxiliaries can be accomplished by one man during an ordinary furnace recharge period, since all but the interrupting contacts are open to view, and removal of six cap screws permits opening of an interrupting chamber for inspection. A complete maintenance job of cleaning insulators and inspecting, and, if necessary, replacing all contacts, and checking mechanical details involves only about two man-hours of work.

As is usually the case with the installation of new devices, certain mechanical difficulties have been encountered, most of which were corrected by minor design changes without serious loss of operating time.

An inspection of this device after approximately 16,000 operations in service showed the contacts to be in exceptionally good condition. The contacts bore no evidence of mechanical wear, and the arcing area of the interrupting contacts showed no more than minor surface roughening. Similarly, the current carrying areas of the isolator contacts were clean and smooth, with the minor markings due to circuit-making restricted to the area adjacent to the arcing horns provided for that purpose. The good condition of the contacts at this time gives promise of high life expectancy, possibly 50,000 to 75,000 operations before renewal is required. At this time, no evidence of appreciable mechanical wear could be detected.

After approximately ten months in service, or about 19,000 to 20,000 furnace switching operations, the performance of this air blast switching breaker leads the operators to believe it represents a significant advancement in this art. Actual cost data is not yet available, but estimates indicate maintenance cost of this switch to be less than one half that of other arc furnace switching devices in similar service. It is the general opinion of the operators that with the complete elimination of the minor difficulties, maintenance will be practically nil.

For use on 15 kv and lower voltage systems, the Type MFL furnace switch has been developed. This unit has an interrupting rating of 600 amperes and a 22 kv class insulation level. It is an air blast device which may be operated on the usual shop air supply.

In appearance this switch is similar to a conventional load break disconnect, but has its contacts provided with enclosures where the interruption takes place. The interrupting force is provided by a blast of air through the interrupting contact enclosure. The closing and opening force for the disconnect is also provided by compressed air. This switch is basically designed to withstand frequent operations and to be simple in

operation, permitting easy inspection and maintenance and replacement of parts, if necessary.

The operating piston is link connected to a toggle crank in such a manner as to provide an overcenter locking arrangement locking the switch in the closed position. The toggle crank is also connected to a cross shaft which operates the switch blades through cranks and adjustable insulating rods.

Compressed air, from the shop supply is stored in a tank after it has passed through an automatic filter. The tank is mounted on the switch. Inasmuch as the tank is under pressure at all times, the switch is ready for immediate operation. This switch is operated electrically by energizing one of two solenoid-operated valves. These valves are energized from a remote push-button station or control switch. To close the switch, the closing valve is energized and air is then allowed to flow from the storage tank to the closing side of the piston. The switch is then driven closed. To trip the switch, the trip valve is energized and air is allowed to flow to the blast valve causing this valve to operate. Operation of the blast valve allows the air in the storage tank to flow through a common header to the blast ports and to the opening side of the piston. Thus, the air blast at the ports is simultaneous with the opening of the switch.

Minimum pressure switches mounted on the air storage tank prevent operation of the switch unless suitable pressure is available for the operation. In the case of a failure of control power, the solenoid valves may be operated manually, thus providing a means for emergy operation. A pressure gauge is provided to indicate air pressure in the tank.

The electrical control circuit is similar to that supplied for any switching device. Pumping is prevented by opening the closing circuit when the trip circuit is energized, and opening the trip circuit when the closing circuit is energized. It is necessary for the closing circuit to be de-energized before the trip circuit can be energized and vice versa.

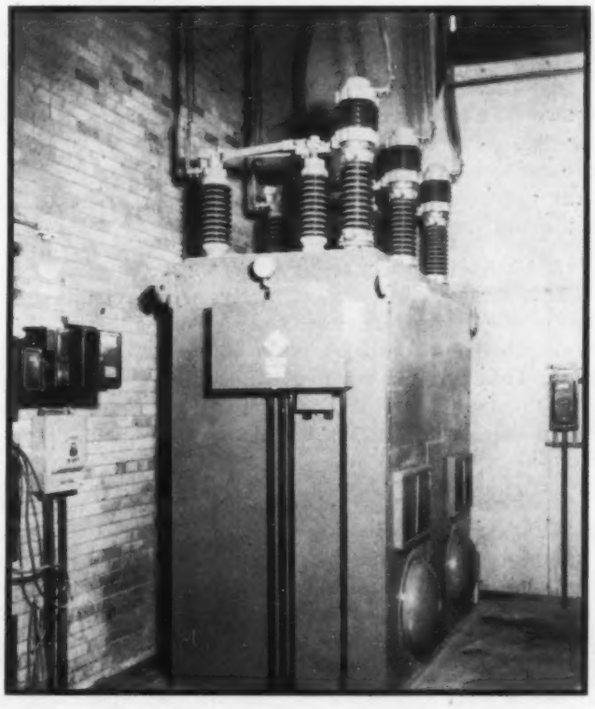
Automatic tripping of this switch on overload may be provided by using the usual overload relays actuated by current transformers on either the primary or secondary side of the furnace transformer. In such a case, it is recommended that lockout relays be included to prevent more than maximum rated interrupting capacity current being interrupted by this switch. It is strongly recommended that this device be used only as a switching device and be non-automatic. It is found in usual practice in many installations that these switching devices do not need to be automatically operated.

This device for use on 15 kv and lower circuits has now been in operation for some time. A second device has just recently been installed, and additional units are now in the process of manufacture.

In conclusion, it appears that while modern oil circuit breakers designed for repetitive operation provide entirely satisfactory performance in arc furnace switching duty when properly applied and maintained, the new air blast interrupter devices just described give promise of distinct advantages for certain applications where the elimination of oil and the reduction of maintenance to a minimum are indicated. Such devices have been built, tested and placed in service on typical arc furnace applications.

It is believed that the devices described will perform their intended function with improved performance and a marked reduction in maintenance time and cost.

Figure 7 — Typical installation of 23 kv, 600 amp carrying capacity, 1500 amp maximum interrupting capacity, arc furnace interrupter switch at Timken Roller Bearing Company, Canton, Ohio plant.



DISCUSSION

PRESENTED BY

A. C. SHEPHERD, Manager of Industrial Sales, The Cleveland Electric Illuminating Company, Cleveland, Ohio

Z. W. WHITEHOUSE, Electrical Superintendent, Republic Steel Corporation, Canton, Ohio

H. G. FROSTICK, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

L. S. STEINER, Assistant General Superintendent, Timken Roller Bearing Company, Canton, Ohio

J. F. CHIPMAN, Engineer, Allis-Chalmers Manufacturing Company, Boston, Massachusetts

A. C. Shepherd: The furnace switching devices presented by the authors appear to be a distinct step forward in this specialized field. In common with most recent developments in circuit breaker equipment, these devices are air operated and air break. The advantages of an oil free breaker are obvious and every indication

points to the eventual domination of this type in the field of indoor circuit breakers.

The duty on a breaker imposed by furnace requirements is of a most severe nature and from the standpoint of frequency of operation far exceeds that for which the standard oil circuit breaker is intended. The circuit opening device presented by the authors was specifically designed for the specialized furnace operating service in contrast to the oil-filled breakers which were necessarily adapted to this use.

The hazard of oil circuit breakers and the difficulty of providing adequate but not too expensive maintenance was illustrated recently by the failure of an oil switch on a furnace operation on our system.

Fortunately, no personnel injuries resulted and the fire damage was limited, but the possibilities of more serious consequences are always present where heavy power feeds are involved, as is the case with furnace operations.

In the case of an installation involving a number of furnaces, a backup circuit breaker adequate to handle the primary faults of the group in addition to the use of an individual switching device for each furnace need not be considered unduly burdensome in view of the number of units.

However, when limited to one furnace, the cost of such a set-up becomes more significant and should be weighed against other possibilities including compressed air or magnetic blowout circuit breakers with adequate rupturing capabilities but with a probability of higher maintenance costs.

In all fairness, it should be borne in mind that the present-day oil circuit breaker is backed by years of development and accumulated field experience, while the air circuit breaker, although most promising, is a relatively newcomer. A certain amount of the seasoning which was needed by the oil circuit breaker, in the past, may reasonably be expected to be required with this newer development.

Z. W. Whitehouse: I think it would be a great thing if the air breakers would do away with the oil switch we have at the present time. We have purchased one but do not have it in operation.

H. G. Frostick: There are a good many points in the paper that might bear discussion. First, the general use of air to replace oil in interrupting devices is good practice. It has been a trend in recent years, and stems probably from the fact that air is an easier dielectric medium to work with than oil for the interruption of electric circuits. Air is cheaper, non-inflammable, and lends itself to a simpler type of construction of the interrupting device.

Second, I would like to touch upon the use of porcelain in a structure subject to high impact shock. There are several new ceramics available, zircon, for example, but as far as is known, it is not generally accepted for high impact shock repetitive loads. Using porcelain for this type service is a moot question which probably will clear itself after some years of operational experience.

Third, there might be some discussion on the ability of this device to close against and carry momentarily currents corresponding to short circuits. As has been indicated, this device requires the use of backup protection. It is not, therefore, in itself an independent switch which will clear a circuit under all conditions. What I would like to talk about then is when an interrupting device becomes a circuit breaker and when a circuit breaker becomes a contactor.

This is a matter of how much closing impact is given to the moving element of the interrupting device. All switches are expected to close against a certain force of current and to open a certain value of current. A circuit breaker is expected to be able to close against short circuits and to open short circuit currents. But a contactor need only to close a circuit. The contactor depends on the backup protection of another device for opening a circuit under short circuit conditions.

Any device using backup protection requires selective relaying to swing the opening from the contactor or interrupter to the backup circuit breaker when the need arises. That type of relaying is not uncommon but it does give a point for potential trouble.

One very important feature of using a contactor with backup protection is that the design engineer is given a little more leeway to work with. The designer is able to build into the interrupting device the characteristics it most needs and to build into the circuit breaker the features the circuit breaker most needs.

In conclusion, I would like to ask the authors one question. In the figures of the oscillograms, on the higher current, that is in the 1730 ampere oscillogram, a fairly good recovery voltage was shown; while on the oscillogram for the 435 amperes, a slight oscillatory effect can be noted in the recovery voltage. The oscillograph is not the very best instrument for measuring over-shoot and surges. Further, these current values are rather high for normal switching and recovery oscillations decrease at heavier currents. It might be expected on good furnace practice that with the electrodes removed prior to most circuit interruptions, all the contactor would be expected to interrupt would be the magnetizing current of the transformer, a current of the order of 20 amperes or less.

My question is, therefore, have tests been made to show what the oscillatory effects are on low currents for this particular interrupting device? I think that tests of this nature would be an interesting and significant indication of the ability of this interrupter to withstand repetitive service.

L. S. Steiner: The breaker that Mr. Chipman described in the first part of his paper was installed on one of the larger furnaces in the plant of the Timken Roller Bearing Company, about the first of December 1944. This breaker when first installed gave us considerable trouble but it was mostly of a minor mechanical nature. Since that time however these difficulties have been corrected and the breaker is now doing an exceptional job.

We are making periodic examinations of the explosion chambers and other parts of the breaker and in spite of the thousands of operations to date we find very little burning, and in fact are having very little maintenance of any kind on this breaker. I believe the Allis-Chalmers Company is to be commended in taking the initiative in developing a breaker for this particularly rugged

service and I believe that our experience with this equipment during the past eight or nine months would indicate that we might expect very satisfactory service from this furnace breaker over a long period.

J. F. Chipman: The general interest in this new type of arc furnace switching device is very gratifying, and the comments of the various discussers are greatly appreciated. Mr. Frostick has raised some pertinent questions which we want to touch upon.

The ambient conditions typical of arc furnace switching device installations are such as to indicate the desirability of the use of outdoor breakers, or when installed indoors, at least of outdoor type insulation, particularly in the higher voltage classes. Porcelain is the most satisfactory insulating material from an electrical point of view, and our previous experience with the use of porcelain had proven it entirely adequate for impact loadings of this type, when the members were properly designed and the loadings correctly applied. As Mr. Frostick has suggested, it may well be that newer types of porcelain will supersede the present types for this and other applications.

The first portion of the paper outlines the analysis of the arc furnace switching problem which led to our proposal of the use of one high interrupting capacity backup breaker for the primary short circuit protection of several furnace circuits, in combination with a furnace switching device, especially designed for the highly repetitive furnace switching duty, in each furnace circuit located immediately adjacent to the furnace transformer primary.

Further emphasis should be placed on the fact that the special arc furnace switching devices described are entirely adequate to handle any circuit condition that may obtain, including secondary short circuits and making and momentary currents; except that they are not designed to interrupt transformer primary faults, which are extremely rare and are best handled by the backup breaker. Where automatic operation of the switching device is employed, suitable interlocks are available to prevent the tripping of the switching device on a primary fault.

As we have pointed out, the elimination of the duplication of the interrupting capacity of the backup breaker in the furnace switching devices, has provided freedom of design to permit the close coordination of the interrupting characteristics of the switching device for the best possible performance on the repetitive switching of the relatively low arc furnace primary switching currents.

Numerous laboratory tests and the operating experience to date have shown no indication that these devices contribute to oscillatory conditions or high transient voltages. The freedom from such tendencies may well be due to the close coordination of the interrupting characteristics for this particular duty. The transients incident to arc furnace switching with particular circuit configurations appear to be a separate problem which is still being studied under a broad program. We trust that the performance of these new devices will justify your interest in them.

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by Paul Haager

ASSISTANT CHIEF ENGINEER

TIMKEN ROLLER BEARING COMPANY

CANTON, OHIO

▲ THE great strides made by the rolling mill industry in the production of sheets and strip to accurate tolerances and at high finishing speeds were made possible by the general use of 4-high hot and cold strip mills.

In the early days of the development of the continuous hot mills, one of the outstanding problems of the time was to provide ample roll neck bearings to safely carry the many indeterminate mill overloads which were so prevalent in those days. The inherent capacity so provided had to be augmented by rolling characteristics which would assure trouble free service and mill roll rigidity sufficient to assure accurate on-gauge mill products.

It is common knowledge that the tapered roller bearing played an important part in this early history of both continuous and single stand hot and cold mills. During this development stage, one of the most usual problems confronting the mill and bearing engineer concerned the matter of mill and bearing loading.

Hundreds of pressure tests were conducted in conjunction with various mill builders and operating personnel in order that these pressures could be properly evaluated for future reference. Unfortunately, such tests do not take into consideration the loading variables that occur with variations in temperatures in the material rolled, variations in the gauge of the material entering the mill, and indeterminate shock overloading due to accidents in the mill. Such variations are usually of a somewhat indeterminate nature and sufficient capacity must therefore be provided by the bearing which is to be used to safely take the overloads without actual injury to the bearing parts. The safe working capacity of a bearing as applied to roll necks in general is dependent upon a number of factors. In the first place, sudden overloads within the static capacity of the bearing do not usually injure any of the rolls or working surfaces. It can be safely stated that sudden overloads up to 5 to 6 times the normal working capacity of a bearing will not injure any of the roller or race surfaces. In cases where sudden shock loadings were anticipated with reasonable accuracy, an actual figure of 8 to 10 times the normally imposed load has been known to exist without actual failure of the bearing. However, excessive overloading when considered as a continuous condition will certainly decrease the tonnage life of the bearing.

It has been the policy of the roller bearing industry to select bearings which will give an acceptable bearing life and at the same time afford sufficient rigidity to maintain accurate pass control and accurate gage in the material rolled. Roller bearings as used on mill roll necks are accurate precision products with the rolls selected to within 0.00025 in. and race concentricity held within 0.0015 to 0.002 in.

The accuracy with which gage may be controlled is not necessarily dependent upon the accuracy of the product within the pass involved, but is more often dependent upon the accuracy of the product entering the mill stand. It is quite generally known that the roughing stages ahead of our continuous hot finishing mill stands are many times not maintained as precision mills, and therefore such factors as off-gage variables of material must be subsequently corrected in succeeding passes. Where a variation of 0.010 in. is permitted to occur from edge to edge in the roughing-stands, the actual finished product after the last finishing stand may still show a percentage of error, regardless of the possibilities of corrections made in the finishing stands involved.

An outstanding example of precision rolling during the roughing stages is a 45 in. × 80 in. 2-high slabbing

Presented before AISE Annual Spring Conference, Chicago, Illinois, May 6, 1946

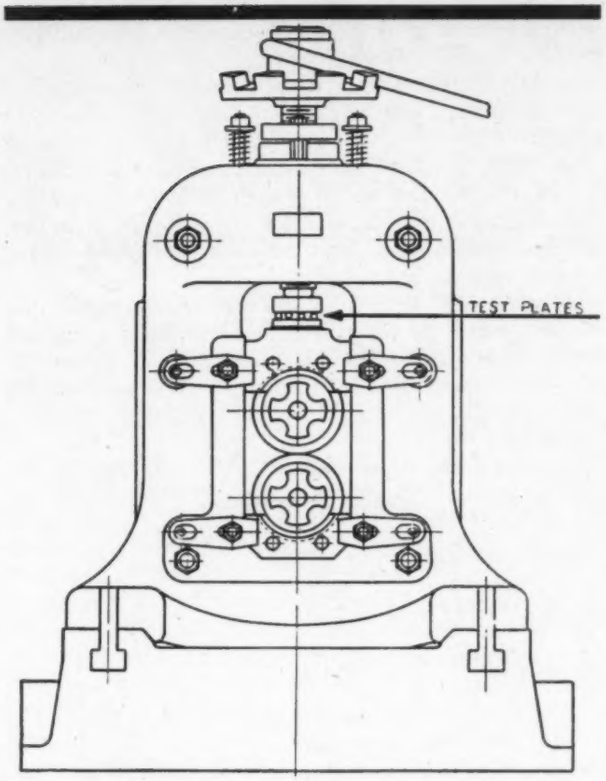


Figure 1 — A test plate has been installed in this small 2-high mill to measure the rolling loads.

mill placed in operation a number of years ago in the Pittsburgh district. The operators have found that close control in the roughing stages has resulted in greater accuracy in the finished product. This roller bearing equipped mill provides the necessary rigidity to maintain proper material gage without the necessity of making continuous adjustments for gage so common with mills equipped with plain bearings.

In addition, the use of non-fluid lubricant made possible in this installation has resulted in a major savings not only in the original costs on type and amount of lubricant but also the reduction of costs of its application.

In taking heavy reductions or in rolling wide widths, it is extremely important that the bearings give free rolling under all combinations of speed and load. This feature is amply permitted in roller bearing equipped mills since the rolling resistance of a loaded roller bearing is practically the same regardless of whether its rotation is continuous or whether it is subject to reversal. This lends itself quite readily to reversing type mills since the reversal in rolling may be accommodated without changing the pressure on the rolls and without the constant danger of marked mill rolls caused by slippage from a sticking bearing. This means greater tonnages through lower scrap loss when related to 4-high or 2-high reversing mills.

LOADING

Hundreds of hydraulic cylinder and brinelled plate tests were originally made to determine the loads encountered when rolling various thicknesses of material in both hot and cold mills. These tests were analyzed as far as possible to determine the characteristics of the material rolled and to apply the knowledge to future predictions of bearing loading for other mills. The original reluctance of the rolling mill operators to divulge certain information on rolling characteristics has practically been removed and the present complete cooperation of the operators is a compliment to the entire industry.

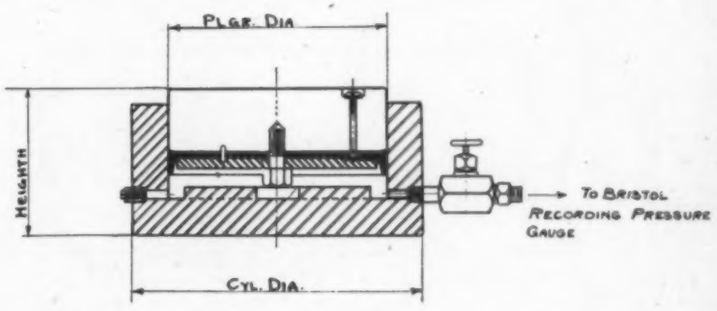
A few years ago, the Association of Iron and Steel Engineers compiled the book "The Modern Strip Mill," which shows quite clearly the whole-hearted cooperation of the entire industry in the exchange of ideas. In addition one must mention the many articles submitted by various members of the AISE at their meetings giving data not previously available.

As a matter of passing interest Figure 1, shows a small 2-high mill in which a test plate as shown, or the hydraulic cylinder would be used. Figure 2 shows a cross section of a hydraulic cylinder as used. When the load is applied the plunger in the cylinder transmits the pressure of loading through a hydraulic connection to a continuous recording meter. This registers loading magnitudes against time. These test results played an important part in determining both average and maximum loadings for which proper operating factors were established to act as a future guide in bearing selections.

The close control of mill loading by the modern use of properly calibrated strain gages adds further assurances of restricting mill separating forces which not only have their effect on roll neck bearings but on all related parts of the mill and rolls as well.

Weighted average loading predictions on single stand reversing or non-reversing mills can readily be made from a proper analysis of the rolling schedules involved, and from the range of loadings and their durations for a given mill stand. Predictions of weighted average loadings on continuous mills present a slightly different problem in that the heaviest loads invariably occur in one of the last two stands, while the lightest loaded bearing usually is found in the first stands. It is there-

Figure 2 — Cross-section of hydraulic cylinder used to measure mill loading.



TESTING CYLINDERS				
PLGR DIA.	CYL DIA.	HEIGHTH	CAPACITY @ 12,000 # □"	NO. USED IN TEST
10 1/2"	13 3/4"	7"	1,000,000	1
9"	11"	6 1/2"	625,000	1
5 1/2"	7 1/2"	5 1/2"	300,000	1
5"	7"	5"	225,000	1
4 1/2"	5 3/4"	3 1/2"	150,000	2
2 1/2"	4 1/2"	4 1/2"	75,000	1

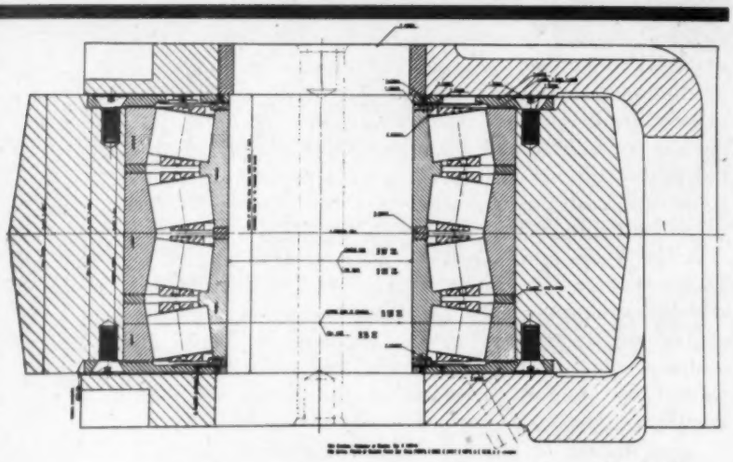
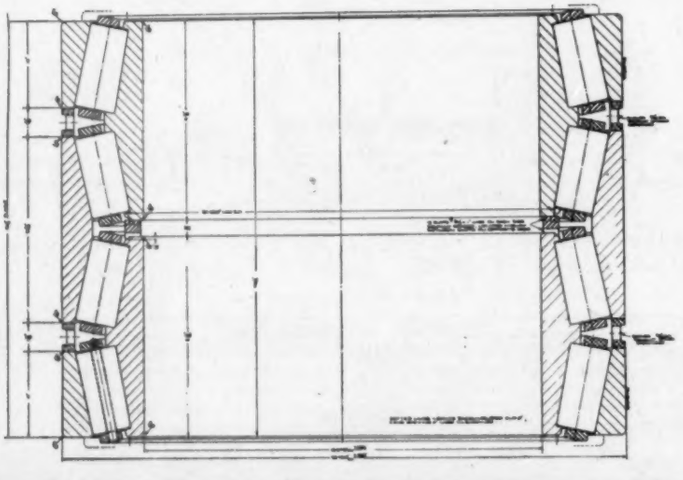


Figure 3 — Bearing arrangement for vertical roll of 52 in. universal structural mill.

fore a common and preferred operating practice to move bearings together with their chocks from the low speed stands to the higher speed stands at regular intervals in order to balance out the overall life of both bearings and chocks.

Some interesting investigations have been made into the maximum loads that may be encountered while cold rolling the lighter gages of the harder materials such as stainless or high carbon steels. In 4-high type cold mills one of the limiting factors of permissible loading rests with the allowable unit pressure that may be permitted between the two working rolls or between the working roll and the backup rolls. Authorities on design of rolls have known for many years that two mill rolls placed in axial contact with each other will become highly elastic under contact pressures of about 400,000 pounds per square inch, and that rolls loaded to this magnitude will give very short life. Neither is it practical to load a roll over 400,000 pounds per square inch without

Figure 4 — Four-row bearing, rated at 800,000 lb at 100 rpm.



getting a rather rapid deformation of the roll itself and thereby reducing the actual effective reduction in the material. Furthermore, the roll life between required regrinds is very low. If the unit pressure is reduced to approximately 270,000 to 280,000 pounds per square inch the mill roll life approaches an acceptable figure.

Actual contact pressures on the rolls of a roller bearing carrying its rated capacity at normal mill operating speeds is about one half of the above acceptable figure for mill rolls.

A practical method of estimating allowable mill loading is to convert the commonly known contact stress formulae by Timoshenko. Table I shows the standard commonly known contact stress formula. By

TABLE I

Contact Stress Formula

$$\text{Contact stress} = 0.591\sqrt{\frac{PE}{Ld}\left(1+\frac{d}{D}\right)}\ \text{psi} \quad \ldots\ldots (1)$$

$$\text{Ultimate} = \frac{15250\ d\ D}{(d+D)}\ \text{per in. width} \quad \ldots\ldots (2)$$

$$\text{Maximum} = \frac{7250\ d\ D}{(d+D)}\ \text{per in. width} \quad \ldots\ldots (3)$$

proper substitution of a contact stress of 400,000 psi in the standard formula and simplifying, we get equation No. 2 which shows the ultimate permissible loading in pounds per inch of roll length which may be used as an approximate guide in estimating the possible but not practical loading on mill rolls. Similarly, by using 275,000 psi as the recommended maximum we get equation No. 3.

The equation No. 3 also satisfies the genuine normal requirements such as found in the rollers in levellers or in other heavy duty highly stressed rolls.

BEARING DESIGN

Tapered roller bearings have in the past for the most part been custom-built and were invariably designed to meet the exact requirements of bore, outside diameter, width or capacity in accordance with customer requirements.

A very common problem for the tapered roller bearing engineer was to offer changeover recommendations to satisfy an existing plain bearing mill or for changeover from other bearing types with which the mill was equipped. This usually involved certain restrictions either on neck or wabbler diameter, or limitations within some available neck length. In other cases the distance between screwdown centerlines or allowable spread of mill housings made it necessary to design a special bearing size and proportion to meet the exact conditions. Due to the constant demands of the industry for these specially proportioned bearings the bearings which gradually became available for general use on new mill installations did not always satisfy the full preferred proportion requirements of what might be termed the ideal tapered roller bearing design.

Special bearings were necessary for installations such as beam mills, bar mills, rod mills, vertical rolling mills,

piercing mills and on the usual hot and cold strip and sheet mills. Due to this tendency to build such a variety of differently proportioned bore, outside diameter and width bearings it was not always possible to select an available bearing for a new mill that would provide the maximum bearing outside diameter permissible for use, with the minimum mill roll diameter specified, and still have a bore which would give a conservative neck stress under the mill separating force applied to the main roll bearings.

A study was made to determine whether it would be practical to establish the ideal bore, outside diameter, width, and proportions for a mill roll bearing by determining the average mill separating force that would be imposed on a mill roll having a certain diameter and having a roll barrel length in line with the present design trends. The results of these studies uncovered some interesting facts which had previously not been entirely evaluated for proper application to a practical bearing design problem. The design features which are now built into the new lines of tapered roller bearings created a number of basic relationships in bearing design including dimensions, bearing rating and neck rigidity. This eliminates previous bearing proportion variations and has brought about a balance in design characteristics. These new lines of heavy duty tapered roller bearings are called "balanced-proportion" bearings.

A brief description of this study should be of interest to most mill engineers who may be charged with the responsibility of contributing to final decisions on the use of bearings in mill roll necks or other heavy duty equipment.

It is an obviously accepted fact that the outside diameter of a bearing which carries the mill separating force is restricted by the roll diameter in which it is used. This permissible outside diameter must allow sufficient chock section adjacent the mill pass line to provide adequate rigidity under load and to permit ample metal to permit the boring operation in the chock without distortion. The determination of the bearing bore and bearing width which may be ideal for the given outside diameter is dependent upon the diameter, length and number of rolls in the given bearing. The importance of increases in bearing rating cannot be over emphasized since an increase of only 23 per cent in bearing rating will provide double the bearing life, and doubling the rating raises the life expectancy to 10 times. However, for practical reasons the rating that can be provided should also be limited by the ability of the roll neck on which the given bearing is used to carry those loads without exceeding permissible neck deflection or stresses. Since neck stress varies directly with bearing width and inversely as the cube of the bearing bore, it is evident that increases in bearing rating may be safely provided by increasing bearing width and bore as long as we maintain the ratio of width divided by bore cubed, in order to maintain neck strength. However, the permissible ratio of bearing roller length to roller diameter in a given 4-row or 2-row bearing is dependent upon certain manufacturing requirements and also upon the limitations found through extensive tests and experience.

The most satisfactory 4-row type bearing design was developed for a specific mill size by analyzing all combinations of practical roll proportions and still provide

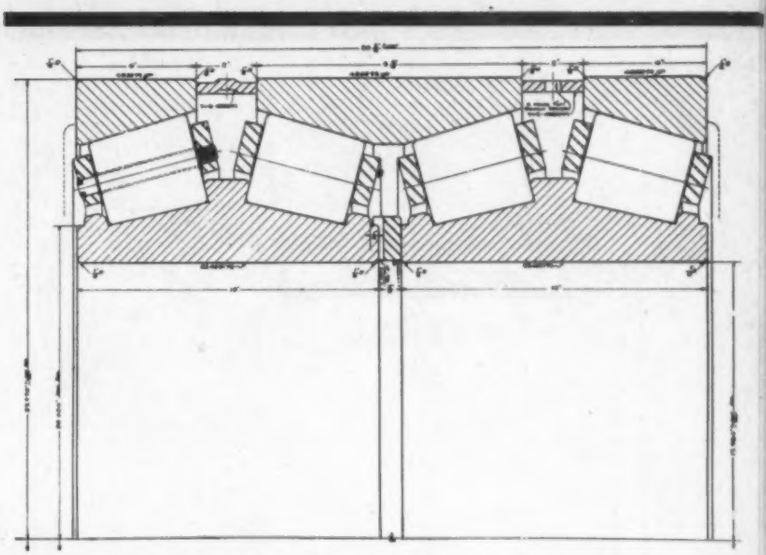


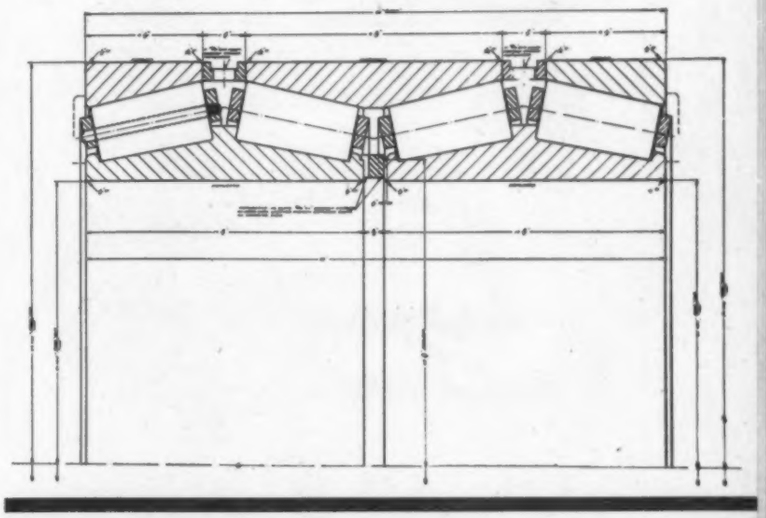
Figure 5 — Old type roller bearing for 16 in. × 34 in. × 42 in. 4-high hot strip mill. The outside diameter is 29.995 in.

the maximum bearing capacity with the minimum neck stress.

It will be recalled that in the first part of this paper reference was made to a practical method of calculating the approximate maximum pressure between mill rolls on the basis of 275,000 pounds per square inch contact stress. In analyzing the aforementioned ideal bearing design a study was made of the usual cold mill roll length to diameter proportions to get an estimate of the above permissible pressure. This calculated load was used as one of the requirements for bearing capacity, and is actually exceeded in numerous cases by the accepted bearing design when operating at the lower mill speeds.

Having now obtained the ideal 4-row bearing proportion it was a case of designing a line of bearings having

Figure 6 — This bearing would now be recommended for the application formerly handled by the bearing shown in Figure 5. The radial rating is increased 26 per cent and it would show 2.2 times as much life.



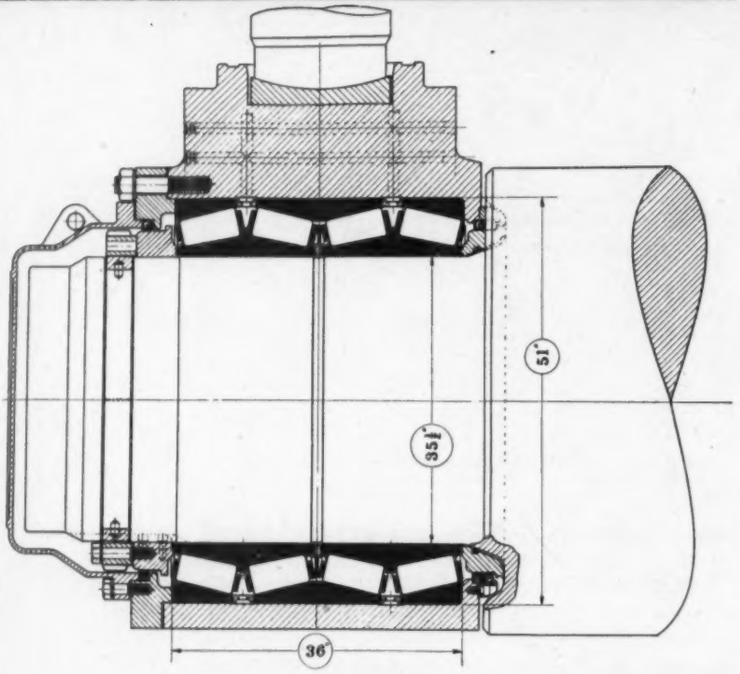


Figure 7 — Bearing installation used on 120 in. reversing hot aluminum mill.

the same overall physical proportions as the given bearing. Due to certain relationships in dimensions and ratings, all bearings in a given "balanced-proportion" line of bearings will show equal neck stresses when each is loaded to a given percentage of its rating.

Such bearings in both 2-row and 4-row types were subsequently established, ranging from the smallest as used in small 2-high mills to the larger sizes used in large hot and cold plate and strip mills with which the trade is acquainted. These are being rapidly adopted in 4-high and 2-high strip mills, 3-high and 2-high bar mills and the usual 2-high rod mills. Their use is extending to piercing mills and the present developing installations of 5-high mills. These bearings have also been gaining popular acceptance for use on rubber mills and calenders. A complete new line of heavy duty bearings, especially adapted for mill gear drives and pinion stands permitting minimum neck stresses and maximum outer race supporting areas, is rapidly becoming available.

These bearings show ratings up to 40 per cent higher than bearings previously supplied and will also show 50 to 60 per cent increases in neck strength. This assures greater mill and bearing rigidity which results in greater precision in rolling.

The following will cover some typical cases of bearing design which will give you a comparison between bearings designed years ago according to certain limitations and the new "Balanced-Proportion" bearing.

Figure 3 indicates the bearing arrangement developed for a 52 in. universal structural mill vertical roll. One unit has been in operation since 1927 in the Pittsburgh district while a second unit has been in service since 1931 on a similar design in the Chicago district. The bearing outside diameter and width was confined to specific restrictions. The vertical rolls, as engineers acquainted with the installation know, are used between the necks of the main rolls and are mounted in pairs with the axes of the rolls in a vertical position. These rolls work on the outside diameter of the structural flanges over the entire width. The rolls are idlers and therefore their rotation must be imparted by the steel passing through the main rolls. Due to the extreme restrictions in bearing space, it was necessary to apply the bearing directly in the roll using what is termed a "dead shaft mounting". In order to provide the necessary capacity it was necessary to use rollers having a large diameter in proportion to their length. This bearing has a bore of 12½ in., an outside diameter of 26½ in., and a width of 16½ in. It has a radial rating of 680,000 pounds at 100 rpm. Figure 4 shows a "balanced-proportion" 4-row bearing with a bore of 18⅞ in., an outside diameter of 26¾ in., and a width of 19½ in. This bearing would have a radial rating of 800,000 lb at 100 rpm or an increase which would show over 75 per cent increase in bearing life. It is also found that the bore of the "balanced-propor-

Figure 8 — Design used in converting back-up rolls on 42 in., 4-high, 5 stand hot strip mill to roller bearings.

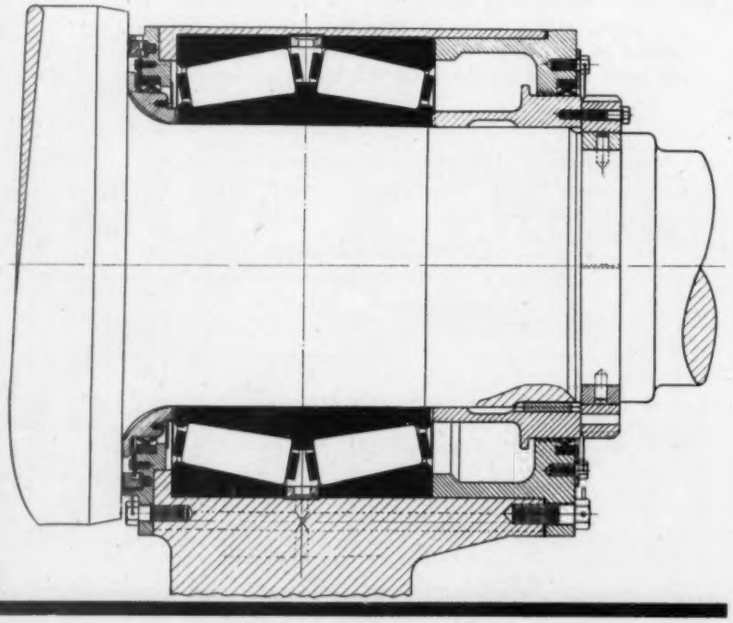


TABLE II

	Carnegie-Illinois Steel Corporation 52 in. beam mill bearings	"Balanced proportion" 4 row Timken bearing
Bore	12½ in.	18⅞ in.
Outside diameter	26½ in.	26¾ in.
Width	16½ in.	19½ in.
Radial bearing rating at 100 rpm	675,000 lb	800,000 lb
Bore	47 per cent	71 per cent
Outside diameter		
Width	62 per cent	73 per cent
Outside diameter		
Rating — "Bal. prop."	1	1.18
Rating — Old type		
Life ratio	1	1.75
Bore ratio	1	1 51
Width ratio	1	1.18

TABLE III

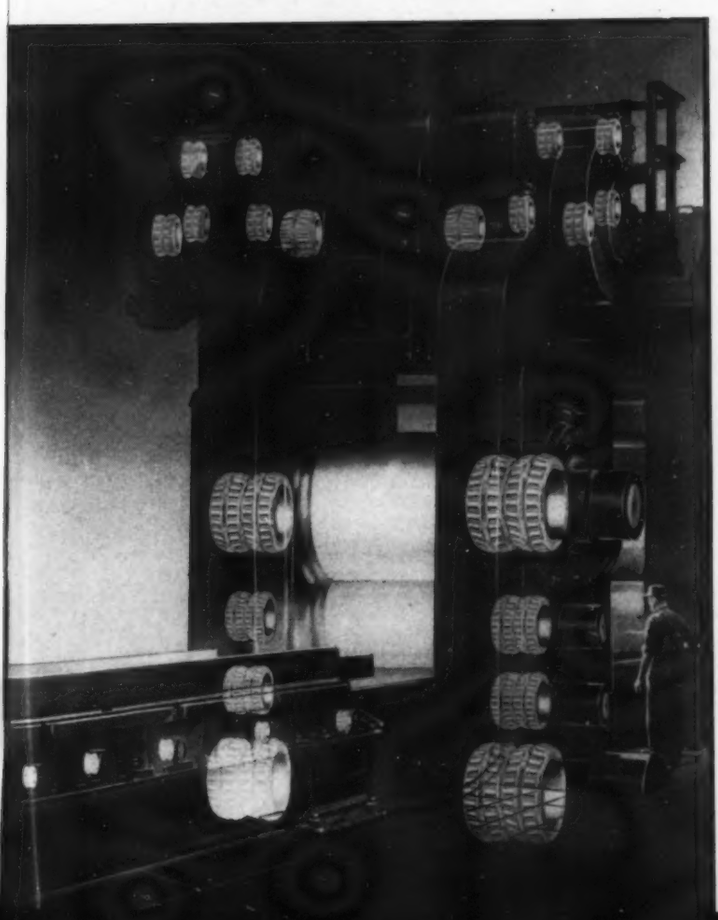
	Carnegie-Illinois Steel Corporation 52 in. beam mill bearing	"Balanced proportion" 2 row Timken bearing
Bore	12½ in.	16⅛ in.
Outside diameter	26½ in.	26½ in.
Width	16½ in.	14⅜ in.
Radial bearing rating at 100 rpm	675,000 lb	670,000 lb
Bore	47 per cent	61 per cent
Outside diameter		
Width	62 per cent	54 per cent
Outside diameter		
Rating — "Bal. prop."	1	1
Rating — Old type		
Life ratios	1	1
Bore ratios	1	1.30
Width ratios	1	0.87
Shaft stress ratios	1	0.40

tion" bearing is actually 51 per cent larger than the old bearing in spite of the fact that the width of the new bearing would only be 18 per cent greater than the present bearing. This increase in bearing width is however, the one factor which will eliminate the possible use of this 4-row bearing in this particular installation. Table II shows the basic comparisons. As a matter of further interest, we have a further development in our line of 2-row "balanced-proportion" series which gives us a differently proportioned bearing that would satisfy all the limitations of the application and provide a bearing giving the same load rating as the existing bearing but showing a 30 per cent larger bore combined with an actual reduction in width of 13 per cent. This would indicate a supporting shaft stress of only 40 per cent of the present installation, if each bearing were subjected to the same load.

Table III was prepared to show the relationships between this latter 2-row "balanced-proportion" tapered roller bearing and the present beam mill bearing. The picture shows the relative relationship of the two bearings especially as it concerns the rollers within the bearing.

The above case should be supplemented by another

Figure 9 — Phantom view of a 4-high mill illustrating usual location of bearings.



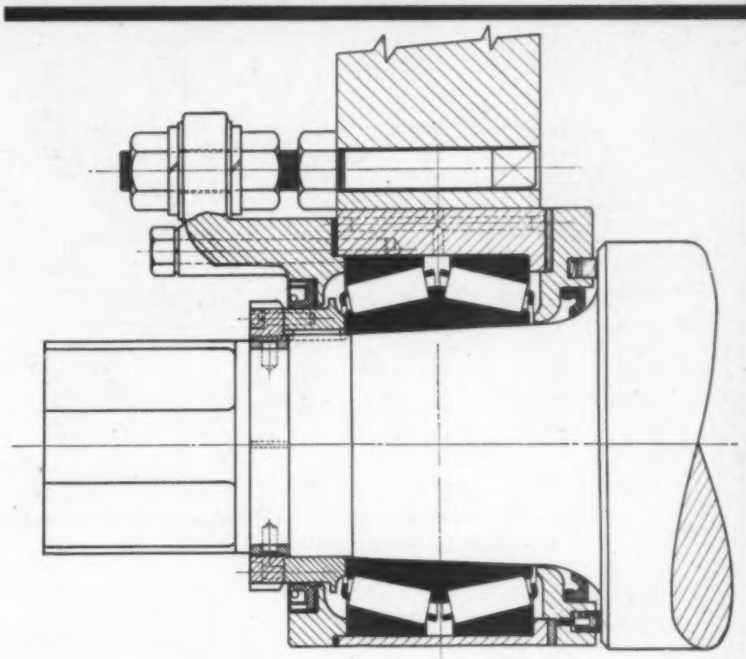
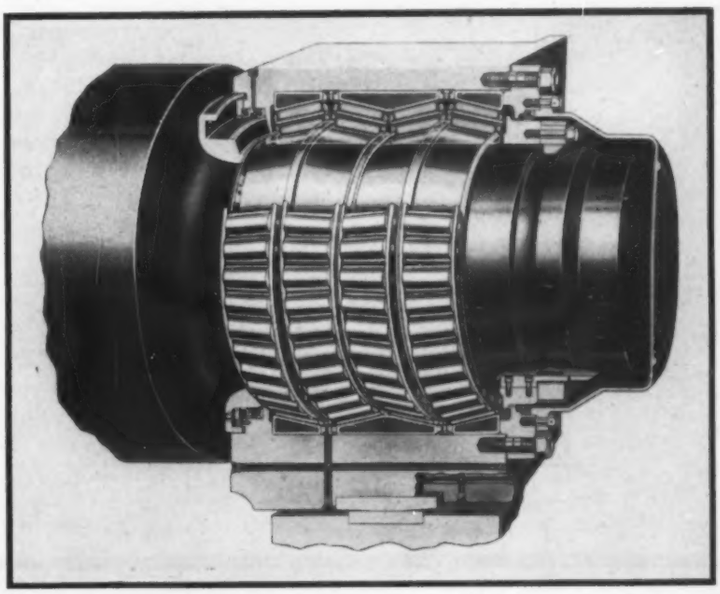


Figure 10 — The bores of the inner race are tapered to permit easy removal.

Figure 11 — "Balanced-Proportion," 4-row roller bearing as used on back-up roll necks.



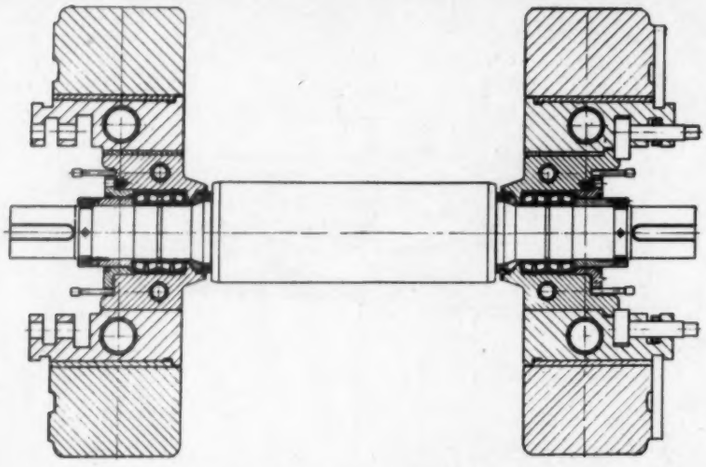
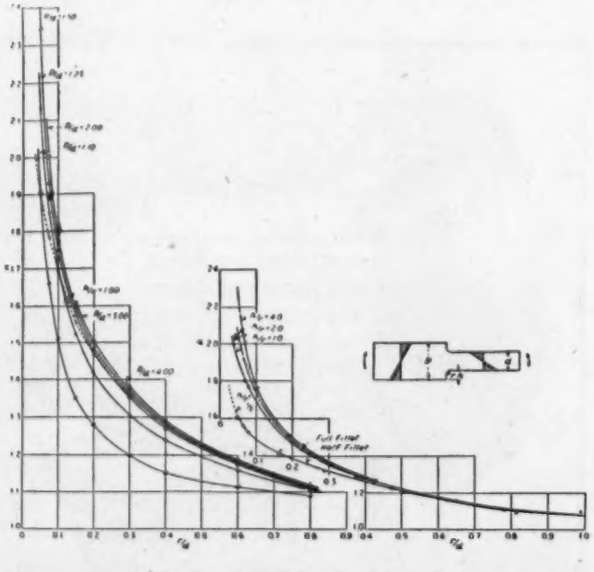


Figure 12 — Arrangement of bearing mountings used on work rolls of 4-high mills.

which is more specifically related to standard types of hot or cold strip mill backup roll bearings.

Figure 5 shows a 29.995 in. outside diameter roller bearing used on a 16 in. x 34 in. x 42 in. 4-high hot strip mill in the Chicago district. This bearing has a bore of 17.984 in. and a width of 20¾ in. Its radial rating is 825,000 lb at 100 rpm. As a contrast, Figure 6 shows a 4-row "balanced-proportion" roller bearing which would now be recommended for this size mill. It has the same outside diameter of 29.995 in. but provides a bore of 21.125 in. and a width of 22 in. This bearing has a radial rating of 1,030,000 lb at 100 rpm which is an increase of 26 per cent over the present bearing and should show 2.2 times as much life. In addition its 17 per cent greater bore combined with slightly greater width will

Figure 13 — The increase in stress or stress concentration in the fillets of roll necks shown in the graphs has been determined from photo-elastic tests.



show a neck stress of about 67 per cent of the bearing now used in this mill. Table IV shows the relationships of these two bearings in table form.

One of the many examples of "balanced-proportion" bearings in service is the hot and cold aluminum reduction mills at the plants of The Aluminum Co. of America. The great demands for aluminum strip for World War II caused the erection of this modern plant in 1941. The production from this mill has been one of the outstanding contributions to the war effort.

This installation covered a 26 in. x 54 in. x 80 in. 5-stand 4-high hot aluminum strip mill, one 35 in. x 59 in. x 120 in. 4-high hot aluminum strip mill, one 35 in. x 59 in. x 120 in. 4-high hot reversing mill and sixteen 32 in. x 84 in. 2-high skin pass mills. The installation uses tapered roller bearings in a multitude of positions including both backup rolls and work rolls. The "balanced-proportion" backup roll bearings on these mills have given trouble free service with low lubrication and overall maintenance costs. The backup roll bearings on the 80 in. mills are 34 in. bore, 48 in. outside diameter and 35 in. width, providing a mill separating force capacity of over 5,000,000 lb. at mill speed. The 120 in. reversing mill uses a corresponding bearing of 35½ in. bore, 51 in. outside diameter and 36 in. width providing a mill separating force of approximately 8,500,000 lb at mill speed. Figure 7 shows the arrangement used on the 120 in. reversing hot mill installation and is typical of the design used on the 80 in. continuous mill as well.

The 2-row "balanced-proportion" bearings have been in operation for a great many years. One example in size involves Timken No. EE925179-925295 which is a 2-row double cone bearing having a bore of 17.995 in., an outside diameter of 29.500 in. and a width of 16½ in. A total of 133 of this size bearing have been shipped with an additional sixteen still on order. These are used in one installation of a continuous hot strip mill and in additional installations of both ferrous and non-ferrous cold mills. The performance of these bearings has greatly exceeded the expectations of the operators in a number of cases where especially heavy loads were encountered.

Figure 8 shows the design used in converting the backup rolls on a 16½ in. x 33 in. x 42 in. 4-high 5 stand hot strip mill to roller bearings. This changeover in the Youngstown district was accomplished with a minimum of expense by reboring the present chocks and remachining the present rolls.

The increased rigidity provided with this bearing has

TABLE IV

	Carnegie-Illinois Steel Corporation 42 in. hot mill Timken bearing	"Balanced proportion" 4 row Timken bearing
Bore	17.984 in.	21.125 in.
Outside diameter	29.995 in.	29.995 in.
Width	20.750 in.	22.000 in.
Radial bearing rating at 100 rpm	825,000 lb	1,030,000 lb
Bore / Outside diameter	60 per cent	71 per cent
Width / Outside diameter	69 per cent	73 per cent
Rating — "Bal. prop." / Rating — Present	1	1.26
Life ratio	1	2.2
Bore ratio	1	1.17
Stress ratio	1	0 67

led to a decided preference in the minds of the operators for the roller bearing installation.

There are a large number of other roller bearing equipped mills that are running on bearings similar to the present "balanced-proportion" design. The bearings used in some of these mills fall slightly short of the ideal design but their performance in rolling high tonnages at low overall costs per ton of steel rolled indicates quite clearly that this new design trend will pay greater dividends to the users of this type of bearing.

MOUNTING

Figure 9 shows a phantom view of a 4-high type mill illustrating the usual location of the bearings on backup rolls, work rolls, screw-downs and table rollers.

Due to the necessity for quick roll and bearing changes the bearings are invariably mounted with a loose fit of both inner and outer races. The inner races are usually mounted with a loose fit of approximately 0.0005 in. per inch of neck diameter. This looseness will permit a slight creepage of the cone on the neck and thereby draw lubricant into the clearance between the bearing bore and the neck outside diameter. Where excessively high speeds are involved, rifle drilling the necks for separate neck lubrication is recommended. On slower speed mills provisions for lubrication of the neck outside diameter with a light coating of regular bearing grease, has been beneficial and economical.

In the case of smaller 2-high strip mills, where the roll life expectancy between regrinds is quite high, two-row double cone type bearings are frequently used and applied with a tight fit on the neck. Special mounting arrangements are provided in these cases to permit easy removal of the bearings from the neck.

In high speed rod mills, the usual mounting involves the use of a tapered bore 2-row, double cone type of tapered roller bearing as shown on Figure 10. This bearing arrangement is used on the finishing stands on a number of installations of rod mills. The bores of the inner races are tapered to permit for easy removal. The thick split shim shown between the inner closure follower and chock is removed to allow the chock inner face to bear against the bearing cone. The bearing may then be easily removed from the neck by wedging between the chock and roller barrel body or by applying pressure against the face of the closure adjacent to roll barrel.

In Figure 11 is shown a typical 4-row "balanced-proportion" roller bearing as applied to backup roll necks. It will be noted that the inner face of the bearing cone is separated from the main roll barrel by means of a fillet ring. The ring, in this case, is clamped to the roll barrel to eliminate any possibility of its turning on the neck. In some cases the ring is made a loose fit on the neck and then locked against rotation to the neck. Where this design is used, it is usually necessary to use a special packing between the ring and the roll barrel to avoid the possibility of water passing through the clearances provided by the loose fit of the ring. The bearing is held against the fillet ring by means of the outer clamp ring which is in turn keyed against rotation and held in its position by means of a threaded nut fitted about a split retainer ring. This retainer ring is fitted into a groove in the roll neck at this point and pinned against rotation. This arrangement provides a very positive means of clamping the bearings. The nut shown is made with a number of slots on its outer diameter to aid in pulling it tight against the assembly. In order to get a vernier variable of locking positions the clamp ring is provided with tapped holes, the number of which is usually one less than the number of corresponding drilled holes in the nut which accommodates the locking screw.

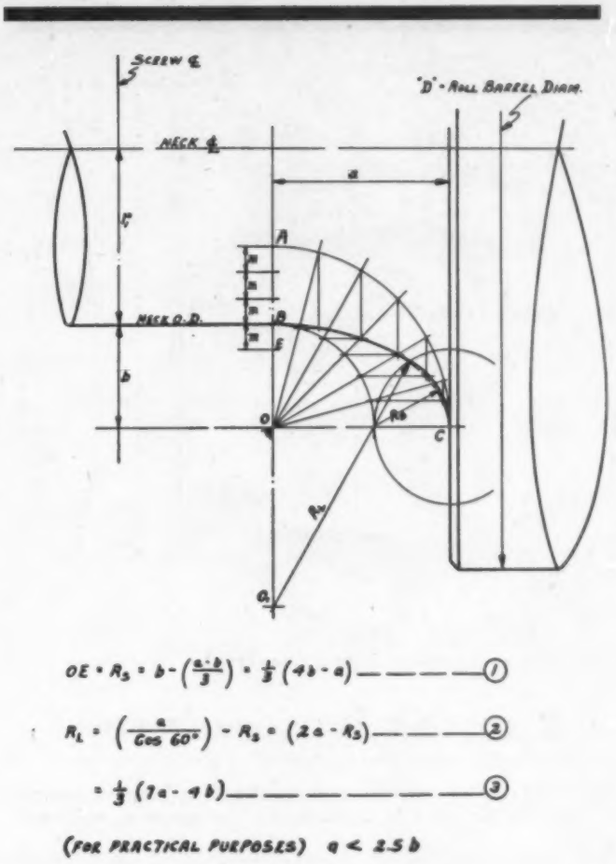


Figure 14 — A compound curve has been developed for the fillet which is readily adaptable to roll grinding.

The bearing is furnished as a complete unit assembly together with proper spacers in order to provide proper controlled running clearance for the bearing and providing possible future compensation for wear from dirt getting into the assemblies.

The faces of the fillet ring and clamp ring as well as the faces of the cone spacer on this application are provided with a number of lubricant slots. These slots allow the lubricant to pass from the bearing chamber to the clearances between the neck surface and the bearing bore. It is obvious that if a bearing is to function satisfactorily it must be properly protected from foreign matter. The closure arrangement shown has been found quite efficient in many installations. The use of a combination of a water or dirt shield with a pair of commercial seals is recommended especially when provisions for lubrication of the clearances between the two commercial seals is made. A unit chock and bearing assembly is provided in order that the chock with bearings

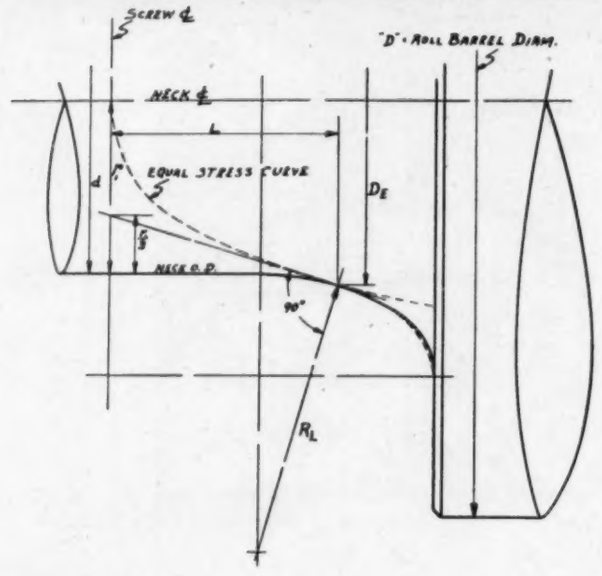


Figure 15 — The sketch shows the dimensions which should be used in calculating the bending stresses.

may be readily transferred from one roll to another without loss or contamination of the lubricant within the bearings. The inner lip extension of these boxes is made with a close running clearance adjacent the inner race of the bearing. The radial flange on the clamp ring holds it with the chock when the unit is removed from a roll. Chocks and bearings may be removed from a roll by merely removing the one clamp nut and sliding the chock with bearing from the neck.

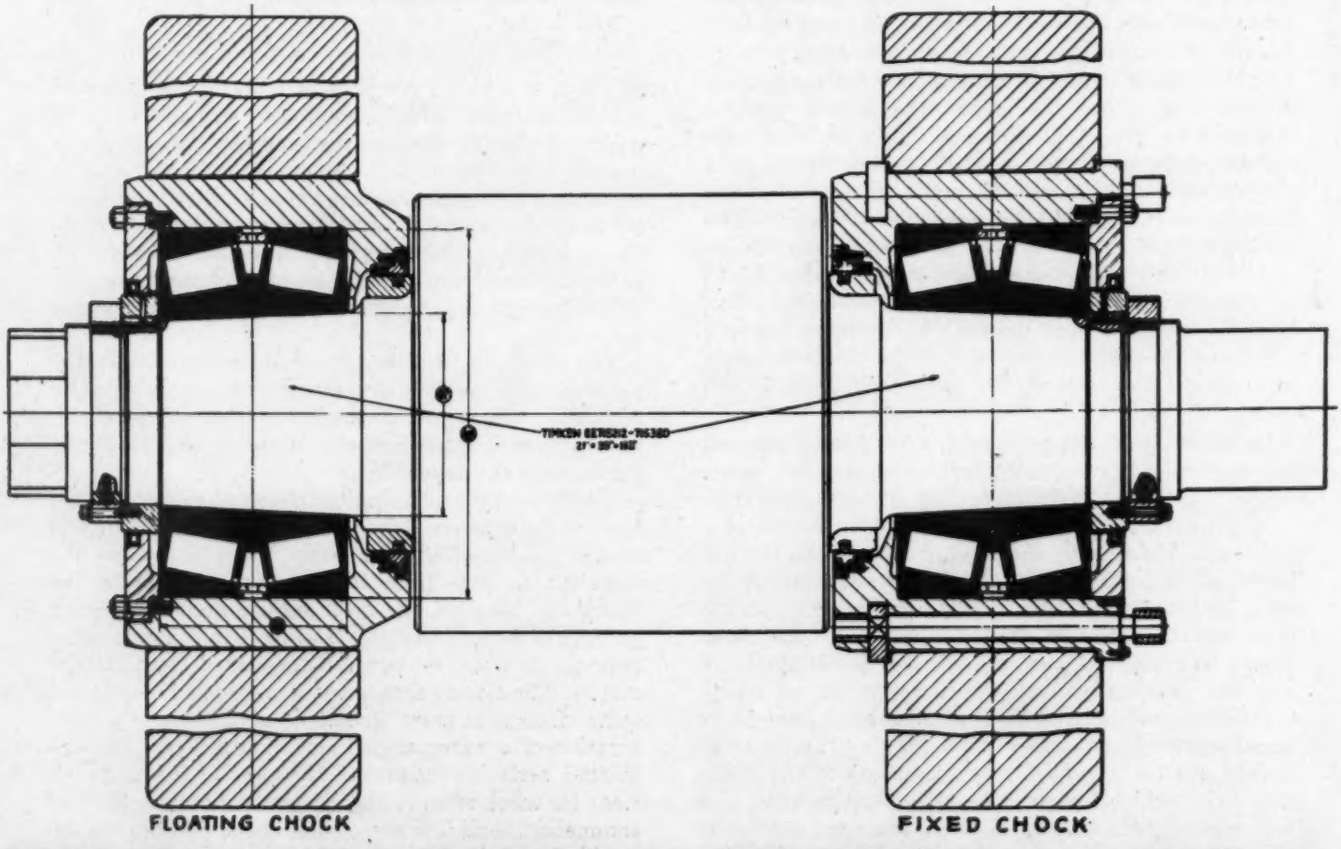
Lubricant is applied to the bearing through leads to each cup spacer. Extreme pressure non-fluid lubricants are invariably recommended for bearing lubrication. No elaborate lubrication tubes or fittings are necessary with this system, thereby permitting roll changes in a minimum of time without loss of lubricant.

Bottom roll chocks are provided with rocker shoes or flats with bevels to permit the chock to rock when sudden momentary overloads occur.

It is to be noted that the roller bearing carries all combinations of both radial and thrust loads and that no external supports such as special thrust units are necessary with this type of bearing.

Figure 12 shows the arrangement of the bearing mounting on work rolls of 4-high mills. The general features of the design are quite similar to that for back-up rolls with the exception of type of bearing necessary.

Figure 16 — Back up rolls on continuous hot strip mill.



The next phase of roller bearing mountings that should be covered concerns roll neck fillets. The principles of optics were combined with the theory of elasticity to provide an experimental basis for studying stresses in various structural and machine design parts. Photoclastic analysis of highly stressed zones in railroad axles was undertaken by the writer's company about 18 years ago and resulted in recommended changes in the design of railroad axles which were later adopted as standards. A considerable amount of research data is available on the subject to those engineers desiring such data.

It is not one of the purposes of this paper to present a new and different analysis on the subject of stress concentration but rather to present an interesting example of correlation of available data to the practical application of steel mill roll fillet designs. The relationship of this subject with the application of roller bearings to mill roll necks has been given considerable study.

The magnitude of stress on a roll neck fillet is usually considered as a mere value of the calculated static stress at the weakest zone of the fillet. However, the relationship of roll neck fillet radii or fillet contour characteristics, as related to neck diameter and roll barrel diameter, should be analyzed and compared with available data on stress concentration factors in order to evaluate the actual equivalent fatigue stress in the fillet zone.

Figure 13 shows values of stress concentration factors as a function of radius of curvature of a fillet. This curve is taken from a paper by Frocht in Mechanical Engineering. The relationship of fillet curvature to roll neck diameters is shown as abscissa. Stress concentration factors for various relationships of roll barrel diameter to roll neck diameter as compared with fillet curvature characteristics are plotted as ordinates.

To determine the equivalent fatigue stress of a fillet in an actual example we take the product of the calculated bending stress as normally found and the stress concentration factor.

The use of a conventional single radius at the roll neck fillet has its limitations and will not always give the most desirable fillet design neither from the standpoint of strength nor by the actual limitations of the design. Use was made of radii and chamfers in a great many instances with considerable success but careful analysis still showed certain disadvantages.

Donald C. Berkey of the General Electric Company completed investigations in the use of elliptical fillets and found desirable characteristics. However the full elliptical fillet design presents difficulty in grinding the contour, therefore, making it relatively impractical. In analyzing this further it was discovered that the use of a compound or two radii fillets not only was a practical solution from the standpoint of roll grinding, but also offered a design that is quite similar to the true elliptical fillet contour. Figure 14 shows the development of this compound radii fillet from two predetermined dimensions of height and length of fillet. It will be observed

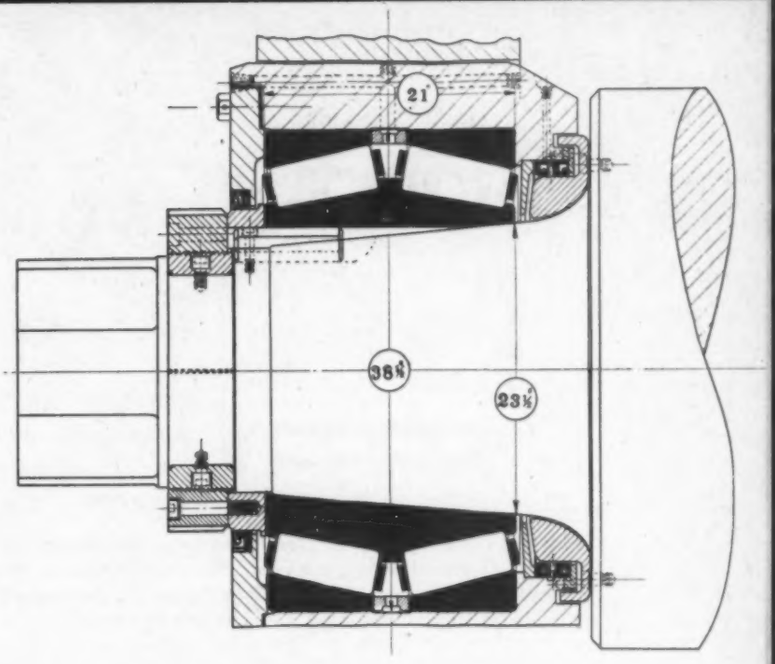


Figure 17 — The design here shown reduces the fatigue stress markedly over that in the present installation.

that "a" and "b" are the length and height of the fillet, respectively. In calculating the two radii of an approximate ellipse for a series of variable "a" and "b" combinations within the usual limits of proportions found in practical applications and comparing these, differences of contour are discovered. The next step was that of determining proper formulae for calculating the major and minor radii for use in practical examples. A trigonometrical and graphical analysis showed that the following formulae are practical relationships.

$$R_S = \frac{(4b - a)}{3}$$

$$R_L = (2a - R_S)$$

Where:—R_S = minor radius a = fillet length

R_L = major radius b = fillet height

a is less than 2.5b (for practical purposes)

Figure 15 shows the working diameter DE, and the working length L, of the neck which is to be used in calculating the bending stress. An equal stress curve is plotted to pass through, and be tangent to, the major radius of the fillet. This will obviously give the maximum bending stress to which the stress concentration factor must be applied. The use of this modified major fillet radius and equivalent roll diameter is also recommended in establishing the concentration factor. Determination of equivalent neck diameter and effective working length of neck can most conveniently be determined by graphical solution.

The above provides a design with a system of comparing various fillet arrangements and proportions in

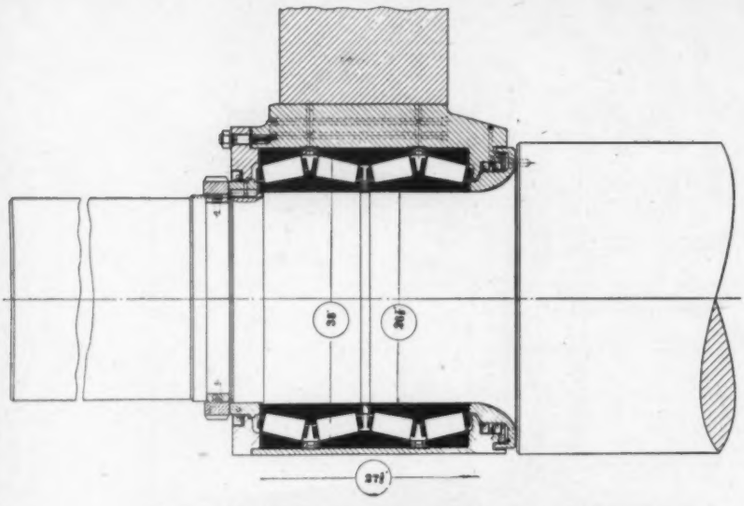


Figure 18 — By the use of four row bearings which increases the distance between the centerlines of the mill housings over that shown in Figure 17, the stresses can be further reduced and the life increased.

order that the most practical contour may be obtained.

A practical example in which the possibility of this type of fillet was combined with both two row and four row bearings is given in the next few figures.

Figure 16 shows the application of a 2-row bearing applied to the backup rolls of a continuous hot strip mill which has been in operation in the Pittsburgh district since 1935. This bearing has a 21 in. tapered bore, a 38 in. outside diameter, and a width of 19½ in. The stress concentration factor at the critical zone in this case is 2.1 due to a ⅞ in. radius on a 21 in. diameter neck.

Figure 17 shows a two-row type "balanced-proportion" tapered bore bearing which was designed sometime ago as a proposal for increasing the mill separating force capacity simultaneously with a substantial increase in neck strength and rigidity. This bearing has a bore of 23½ in., an outside diameter of 38½ in., and a width of 21 in., and will fit into the same chocks with only a few minor changes. It is of interest to note that the calculated bending stress is only 71 per cent while the equivalent fatigue stress is only 46 per cent of that of the present installation, for a given mill separating force. This is the result of the use of a major fillet radius of 9¼ in. against ⅞ in. radius on the present installation.

In addition, the increase in rating provided by the use of this bearing should give 73 per cent greater tonnage life.

As a further comparison we would now be in a position to apply one of the new 4-row "balanced-proportion" bearings into this mill by increasing the distance between the present mill housing center lines by approximately 6 in. This bearing is shown on Figure 18. It has a 26⅞ in. bore, a 38 in. outside diameter and a 27⅝ in. width. The calculated bending stress on the neck is only 56 per cent while the equivalent fatigue stress is only 37 per cent of that of the present installation. The major radius at the fillet is 9 in. in this case.

Table V shows a general comparison chart of all three bearings thereby indicating quite vividly the advantages that are obtainable in considering the new type of roller bearing on mill roll necks and some of the possibilities of improving roll life by proper fillet designs.

In spite of the possibilities of improving the existing bearing application it is interesting to report that there are many of the originally installed bearings still in service with approximately 3,000,000 tons.

It is a foregone conclusion, however, that all of these factors of larger necks, greater bearing capacity, and improved fillets must be balanced by carefully selected mill roll material characteristics.

It is known that excessive breakage of mill rolls has in some cases been traced to "below-par" rolls rather than by undesirable physical proportions. In addition it is also rather obvious that a carefully planned inspection and maintenance program should be diligently followed in order to assure the repair or replacement of badly worn mill parts which many times are responsible for such excessive roll breakages.

TABLE V

	Present installation Timken 2 row tapered bore	Proposed Timken 2 row balanced proportion bearing	Possible Timken 4 row balanced proportion bearing
Bore	21 in.	23.500 in.	26.875 in.
Bore ratio	1	1.11	1.28
Outside diameter	38 in.	38.500 in.	38 in.
Width	19½ in.	21 in.	27⅝ in.
Mill separating capacity at mill speed, 1800 fpm	2,030,000 lb	2,400,000 lb	2,900,000 lb
Rating Ratio	1	1.18	1.43
Tonnage expectancy ratio	1	1.73	3.33
Calculated bending stress ratio	1	0.72	0.58
Major fillet radius	⅞ in.	9¼ in.	9 in.
Concentration factor	2.1	1.28	1.32
Equivalent fatigue stress ratio	1	0.44	0.37

Metallic Bearings

. . . . recently the AISE sent out a questionnaire on bearing design and usage to a group of over 100 bearing engineers and users . . . . one engineer's answers to these questions were used as the basis of this paper . . . .

by H. L. Smith

FEDERATED METALS DIVISION

AMERICAN SMELTING AND REFINING COMPANY

PITTSBURGH PENNSYLVANIA

▲ IN preparing this paper on the subject of metallic bearings, it was thought advisable to use a questionnaire prepared by the Association of Iron and Steel Engineers which indicated that the subject concerns designers, engineers, mechanics, and maintenance men alike.

We are metallurgists who smelt and refine metals that are used in bearings, and in order to manufacture any high quality product the producer must be fairly well acquainted with the operating conditions required of his products and the various channels in which they are used. It is in the light of such experience, which obviously has brought us in close contact with bearing problems in general, that we submit answers to the various questions as follows:

It is a coincidence that the first question, "What length to diameter ratio do you consider a safe minimum in bearing design?", permits a discussion of the history of bearings and bearing alloys. In the majority of older type or non-precision bearings, most engineering references advise that the length of the bearing should be two to three times the diameter, but where steps have been taken to apply certain fundamental bearing principles that will be discussed further in this paper, good bearing operation is obtained by reducing the length of the bearing to 1 or 1½ times the diameter. In modern equipment where precision bearings are used, the ratio of length is still further reduced to about ¾ or less of the diameter. Thus it can be said that the lower the ratio of length to diameter, the greater the degree of precision required in both the making and installation of bearings.

The reason for this difference in the ratio of length to diameter between precision and non-precision bearings can be answered in a study of the history of bearings.

In the year 1839 a most significant development occurred. Sir Isaac Babbitt patented a bearing which consisted of a steel or bronze shell with a white metal lining. Although the patent covered the principle of using a soft metal supported by a stronger shell rather than a specific alloy, a formula was also recorded in the patent which approximated 89 per cent tin, 9 per cent antimony, and 2 per cent copper. In this connection, a recent writer on the subject states that the prototype of the bearing metal is still the 100-year old babbitt metal, which was one of those truly happy hits of craftsmanship on the basis of which other bearing metals have been developed essentially by analogy.

With such a babbitt available for the past 100 years, and the designer little limited with regard to size and weight of construction, bearing dimensions were adjusted through the years to meet operating conditions. Hence, in the past when a bearing failed there was little study given to the cause of the failure, but its size was increased until no further failure was encountered, which is the reason why most of the older type or non-precision bearings of today are oversize compared to their true load carrying capacity. Even with the conventional tin-base babbitt and large bearings, a great number of failures still arise due to not making the bearings properly, deflections of the journal, poor alignment, etc. In many cases, however, it would be rather costly, if not impossible, to install precision bearings, and in these cases the larger bearings, which are part of the equipment, must obviously still be used. However, with a little systematic study, these older bearings can be made to give longer trouble-free service by using a bearing alloy which possesses the desired physical characteristics for the service intended,

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and then making the bearing properly by applying certain fundamental principles of good foundry practice and lubrication.

The second question, "What running clearance do you require with respect to bearing diameter?", is likewise quite important. Experience indicates that in general 0.001 of an inch per inch of shaft up to six inches is usually sufficient, and for bearings over six inches 0.0005 inches is added for every additional inch of shaft, but two things must be taken into consideration. One is the expansion of the babbitt, and the other is the expansion of the shaft. Lead-base babbitt expands more than tin-base babbitt, hence where thick babbitt linings are used it is obvious that greater clearance must be allowed when using lead-base babbitt than with tin-base babbitt.

As an example, if a steel shell were lined with lead-base babbitt ½ inch thick, the babbitt would expand more than the steel and thus produce an inverse expansion that would, in turn, reduce the inside dimension to a greater extent than if tin-base babbitt were used. In many of the older type bearings the clearances progressively increase beyond the figure just given until they become so great that line contact is encountered between the journal and the bearing lining, in which case the journal must seat itself in the bearing metal during the early stage of operation or the break-in period. In such bearings, there must be a direct relation between the hardness and other physical characteristics of the bearing alloy, the temperature generated in the first few minutes of operation, and the ability of the bearing to radiate and dissipate heat. It is not uncommon to find a good babbitt metal suffer condemnation because of improper analysis of what caused the failure to occur. This is particularly true in those cases where the bearing is not in proper alignment with the shaft or where the shaft itself deflects excessively.

In this connection, a study of a time temperature curve of certain line contact or self-seating bearings reveals that many bearing failures are caused by a very rapid and excessive rise in temperature as the shaft seats itself in the bearing metal during the first minutes of operation. The time temperature curve should rise steadily until the shaft forms an area in the bearing alloy sufficient to support the load with adequate lubrication, at which time the curve should approximate a horizontal straight line at the desired operating temperature.

This leads to question No. 3, "What bearing pressure, in pounds per square inch, do you consider as maximum for plain bearings of the conventional type?" Assuming that operating conditions are normal, (a) high tin-base babbitt will stand about 1,000 psi, (b) high lead-base babbitt, will do likewise, (c) high lead bronze will support about three times this figure or 3,000 psi, while the bronzes (d), conventional brass (e), and composition (h) will generally take somewhat higher loads, (f) aluminum alloys used in bearings will stand approximately 1,200 psi, and (g) the cadmium-nickel alloys about 2,500 psi.

These values are for precision bearings, about half of which can be considered normal for the ordinary type of bearing. Also speed and shaft hardness are important factors when considering aluminum bronze, conventional brass, aluminum, and cadmium-nickel.

In connection with bearing pressures, it is essential that the designer or the maintenance engineer be familiar with the inherent physical characteristics of the different bearing alloys. A brief discussion of the merits of certain tin-base and lead-base alloys, for example, may prove beneficial at this point in the discussion.

A comparison of their physical properties will reveal that certain lead-base bearing alloys possess properties which are equal, and in many cases superior, to the old tin-base babbitt.

The tin-base bearing alloys have usually proved their superiority, particularly in internal combustion engines where the bearings are subjected to elevated temperature. Since the data in the literature cover very largely the properties of lead-base bearing alloys at room temperature, the failure of the physical properties to indicate the relative merit of tin-base and lead-base bearing alloys is due to the measurement of these properties only at room temperature.

Therefore, the properties of the various accepted bearing alloys should be measured over a range of temperature wide enough to include the highest temperature at which bearings normally operate. This procedure indicates that the properties of most lead-base bearing alloys fall off more rapidly with increase in temperature than do the properties of tin-base bearing alloys. A further factor which proves to be of greater significance is the time at the elevated temperature. When bearing alloys are held, for example, at 150 C (302 F) for a period of many days, it is found that with all the conventional lead-base alloys, the properties fall off much more rapidly with time than do the properties of the conventional tin-base babbitt. Certain lead-base alloys, however, are available that have properties close to those of tin-base bearing alloys, and in addition will retain their hardness over long periods of exposure to elevated temperature. Rather than recommend any particular alloys in this symposium, I would suggest that you contact metal producers who have the necessary data.

Question No. 4, "What added factor of safety do you require for the above where shock load and/or intermittent, stop-start, operations are encountered?", may be considered part of Question 3. For precision bearings no factor of safety is generally required except that it is necessary to determine maximum load conditions correctly. For example, in certain internal combustion engines the bearings withstand the maximum load for which the unit is designed at the maximum operating speed, yet the same bearings can be made to fail by eliminating all outside loading and just increasing the rpm by about 10 per cent beyond the maximum specified. This increase in rpm produces high inertia load, which is defined as the load encountered when the piston changes its direction from an upward to a downward motion. There is a test in which the speed of certain engines designed to operate at 3600 rpm is increased to 4000 rpm, and this increase in rpm increases the inertia load beyond any actual operating load encountered under normal operating conditions. Thus bearings should be designed to operate safely within the true maximum load carrying capacity re-

quired of them. For non-precision bearings, the length to diameter ratio usually absorbs any safety factor that is necessary, because, as already discussed in the history of bearings, when the older type bearings failed, their size was merely increased until no further failure occurred, whether it was due to shock loads or intermittent stop-start operations or some other cause.

This leads to the fifth question, "What method, if any, do you employ for determination of the width and depth of bearing grooves with respect to the working diameter of the bearing?" Generally both the depth and width of bearing grooves should be about the same. It is difficult to predetermine the minimum size of bearing grooves, but they should be large enough to feed sufficient oil for lubrication at the desired place. As a rule with a one-inch shaft the bearing grooves can be about $\frac{1}{32}$ of an inch wide and for a larger shaft of about 22 inches in diameter, they may be approximately $\frac{1}{4}$ of an inch wide.

Question 6, "Where should grooves be located with respect to the load zone?", is probably more important. Grooves should be located in the unloaded area of the bearing and so placed that they direct the lubrication toward the center just ahead of the load. The only grooves that should ever be in the loaded area of a bearing are oil retainer grooves, usually found at each end. Radial oil grooves are desired by most bearing manufacturers together with what might be called spreader grooves to carry and feed the oil toward the center just ahead of the load, as just mentioned. Grooves which tend to feed the lubricant toward the ends of the bearing do not prolong bearing life. This type of groove is exemplified by the old type X groove. Shaft pressures will press the oil toward the end of the bearing without groove assistance. A groove in the loaded area of the bearing is not recommended because in that position a groove acts as a scraper of the lubricant instead of a distributor. For two-piece bearings which are usually designated as top-half and bottom-half where shims are used, the shim should be filed or machined to fit the contour of the bearing grooves. If they extend beyond the groove toward the journal they will act as a scraper and thus retard the flow of lubricant when it reaches these side grooves or pockets which are intended for oil feeding.

The point of oil entry has a very definite relationship to bearing life. Loads may vary as to their position. That is, one bearing may have the load on top while another may have the load on an angle. Since the best practice is always to enter the oil just ahead of the load, as previously mentioned, it is therefore advisable to determine the location of the load by inspecting the bearing before removing the old babbitt, and then making the necessary corrections according to the recommendation just given.

Question 7, "How far from the end of the bearing should the grooves be terminated?", depends somewhat on the size of the shaft. For a 24 inch shaft, the groove should be terminated about one inch from the end of the bearing. For smaller shafts they may go as far as $\frac{1}{8}$ to $\frac{1}{4}$ of an inch from the end of the bearing. Much depends on whether oil retainer grooves are used or not. Oil retainer grooves as a rule are not used unless there is excessive squeezing out of the lubricant at the ends of the bearing, but if there is excessive squeezing out of the oil, then the oil retainer grooves may be used, but they should be feathered toward the center of the bearing in which case the grooves should end about the distance just mentioned from the oil retainer groove.

Question 8 is "What surface finish, if any, do you require in the selection of plain bearings?" Most bearing manufacturers desire a smooth bore finish, but what is of particular importance is to have the bearing surface precisely parallel with the shaft, and any tool marks which may appear should likewise be parallel with the shaft. Tool marks should never follow with the circumference of the bearing as such marks may cause minute scratches on the journal, which can develop into large cracks, and in turn cause the journal to break.

In this connection also is question 9, "What surface finish and/or hardness, if any, do you require regarding the shaft or journal involved?" The shaft should be smooth as any tool marks may scratch the bearing metal which is objectionable and is the incipient cause of many failures, but if tool marks do or must appear they should be parallel with the shaft and never in the direction of the circumference. As to shaft hardness it is generally accepted that babbitt metal gives the longest life against a shaft of about 150 Brinell, while the best leaded bronzes require a shaft of about 230 Brinell. The 80/10/10 mixture requires a higher hardness for higher speeds and loads.

Question 10, "What range of limitation as to maximum and min mum bearing thickness do you require?", is highly important. As a rule, the thinner the babbitt the higher the load carrying capacity of the bearing. Precision bearings usually begin with a babbitt thickness of about 0.005 inches minimum, which extends upward through non-precision bearings where $\frac{3}{8}$ of an inch, and never over $\frac{1}{2}$ of an inch should be used. For those bearings which have an excessively thick babbitt layer, that is, over $\frac{1}{2}$ inch, the shell or backing should be built up to a point where not more than $\frac{1}{2}$ inch of babbitt is necessary to finish the bearing to the prescribed dimensions.

Question 11, "What is the maximum operating temperature that you believe should be set for the various types of bearing material?", is probably as important as any question in this questionnaire. There is not too much information on the exact temperature at which different bearings fail, but the leading bearing manufacturers do not find it practical to run over 180 F. One of the engineering references states that an examination of the temperature of bearings of a large number of engines of various makes show that more are over 135 F than below that figure and that many bearings were running at a temperature over 150 F, and in one case at 180 F; and in all these cases the bearings were giving no trouble. If for any reason bearings must operate beyond 180 F, the elevated temperature properties of the bearing alloy should be precisely understood, because as previously mentioned in Question 3 under bearing pressures, it was shown that certain alloys lose their properties over a period of time at elevated temperature.

Question 12, "What CN/P value do you consider mandatory to good operating practice for normal service conditions?", is rather difficult to answer. I

quote from Machinery's Handbook, which states that the range of ZN/P values or the ideal one for a given bearing can only be determined by actual test; that is, by combining the maximum speeds with minimum loads and vice versa, because the allowable unit pressure for a given velocity and lubricant depends upon so many variable factors. Also these values for a given bearing in the zone representing the dividing line between stable and unstable lubrication may change considerably as the bearing surfaces are worn smooth by running in. An example is given of a test on a bronze bearing which resulted in a ZN/P value of 55 at a point of minimum friction or danger zone and a reduction in this value to about 5 after 75 hours of running. As the value of ZN/P decreases, the coefficient of friction decreases until the oil film begins to break down. Then frictional resistance increases as the contact with the journal is transferred from the oil film to the bearing material, the rate of increase depending upon the extent to which the lubricant may remain and the frictional resistance of the bearing material itself. It is evident that frictional losses are lost when a ZN/P value is close to the value representing a change from stable to unstable lubrication.

In this connection I would also like to include Question 13, "What ZN/P value to you feel will cover shock loads and/or intermittent (stop-start) service operations?", which can probably be better answered by a lubricating engineer rather than a metallurgist. Thus, for further reference, the Texas Oil Company as well as a number of other companies have considerable literature on this subject and much more than can be discussed in this symposium.

Question 14, "What temperature-viscosity relationship do you feel is conducive to safe operating practice?", can be found on the American Society for Testing Materials viscosity temperature chart, where the various relationships depending upon the particular problem can be obtained. In this connection it is necessary, however, to consider the heat radiating capacity of the bearing in question. To prevent excessive heating, the heat generated must not exceed the rate of radiation after the bearing is up to the maximum running temperature. Most of the engineering handbooks give formulas covering safe operating conditions and give radiation in foot pounds per minute of projected area for well ventilated, unventilated, and thin bearings.

The answer to Question 15, "What type of seal design do you favor in plain bearing installations?", is rather short as the conventional oil seal is generally recommended by most bearing manufacturers.

The last question, No. 16, "What additional requirements do you believe should be standardized regarding plain bearing applications?", is as important as any question heretofore discussed. Unless bearings are properly made there is no need to look into the fundamentals of bearing design and operation, as the very first and most fundamental requisite toward obtaining maximum bearing performance is to make sure that they are properly made. With this thought in mind, and as a specific answer to the question, I would like to direct your attention to a technical manual prepared by the Federated Metals Division of the American Smelting and Refining Company, and to a paper written by Mr. T. E. Egan and Mr. W. R. McCrackin of the Cooper Bessemer Corporation, which was delivered before the American Institute of Mining and Metallurgical Engineers at the New York meeting in February, 1944. The bearing manual is a treatise on how bearing alloys should be melted, how they should be bonded and cast on the shell, what causes certain bearing failures, corrosion problems, and the like; while the paper by Mr. Egan and Mr. McCrackin covers the effects of segregation in babbitt, its structure and the recommended practice for casting certain bearing alloys.

Time does not permit discussing this all important subject, but a thorough study of the principles set forth in these two publications will assist greatly in evaluating and correcting bearing problems in general.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. OF

IRON AND STEEL ENGINEER

(Required by the Acts of Congress of August 24, 1912, and March 3, 1933)

Name of Publication: *Iron and Steel Engineer*, published monthly at Pittsburgh, Pennsylvania. (Report of October 1, 1946.)

State of Pennsylvania
County of Allegheny

Before me, a notary public in and for the State and county aforesaid, personally appeared T. J. Ess, who, having been duly sworn according to law, deposes and says that he is the editor of the Iron and Steel Engineer and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

Editor: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.

Managing Editor: None.

Business Manager: James D. Kelly, 1010 Empire Building, Pittsburgh, Pennsylvania.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

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T. J. ESS, Editor.

Sworn to and subscribed before me this 27th day of September, 1946.

G. WILLIAM JONES, Jr., Notary Public.

(My commission expires February 9, 1947.)

Bearing Seals

. . . . steel mill bearings need complete protection against the entry of water and scale as well as the loss of the lubricant . . . .

by L. G. Krug

CHICAGO RAWHIDE MANUFACTURING COMPANY

CHICAGO, ILLINOIS

▲ STEEL mills today operate under conditions involving water, speed, pressure and considerable range in temperature. Bearings are designed for great loads and plenty of good lubrication. The use of high pressure descaling sprays deluging the roll neck bearings with water and the development of the sleeve type flood lubricated bearings have focused attention more and more on the need for bearing protection. Steel mill bearings need complete protection against the entry of water and scale as well as the loss of lubricant. This protection is obtained by the use of what is commonly called an oil seal. An ideal oil seal would operate without interference to free shaft rotation, cause no shaft wear, nor give off any heat through friction.

The subject of this paper concerns these steel mill seals. In this business all seals over a 15 in. shaft diameter are referred to as steel mill seals regardless of their ultimate use. Size makes quite a difference in design and production. What presents no problem in a small seal looms as an impossibility in large sizes. Of all manufacturers making seals there are only two or possibly three who really produce big seals for complete steel mill bearing protection. In general there are two types of seals used: the end face shown in Figure 1 and the shaft seal. End face or surface type seals are at present used only to exclude water while the more popular shaft seal operates both ways, retaining lubrication as well as excluding water and foreign matter.

This discussion will start with the shaft type seal shown in Figure 2 which is described as follows: It is a self-contained unit, consisting of a flange or hat shaped sealing member, metal encased, with the packing element held against the shaft by means of a spring. This is a rather broad definition of a shaft seal and covers a great variation of related designs. All, however, work on the same principle. The sealing element, see Figure 3, must have a sharp edge in constant contact with the shaft so that the film of material, (oil, grease or water) is cut and prevented from further passage past the seal. The packing member is secured tightly to the metal case, which in turn is press fitted into a bore so an effective seal is obtained.

Now that we know how a shaft seal works, let us consider the various designs developed to accomplish the desired results. The metal case is a logical choice for a start. All but one seal on the market today have metal shell encasements. These cases must be accurate as to the outside diameter and allow for a 0.005 to 0.010 in. press fit into a housing bore. There is no leak possible through this fit and the seal remains in place without the use of a locking plate or snap ring. The one exception not using a metal shell has a canvas and synthetic rubber outside wall. It is easy to install but

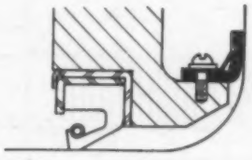
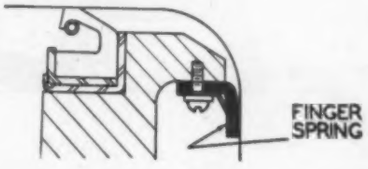


Figure 1 — Flange type end face water seal.



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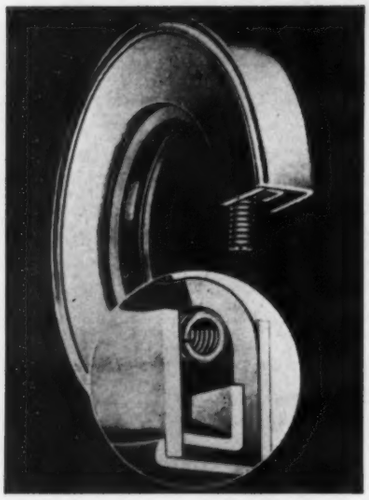
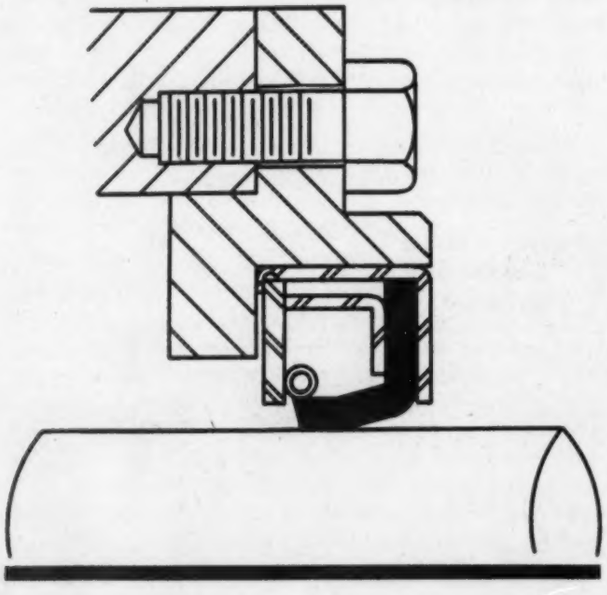


Figure 2 — The typical shaft type seal retains lubrication as well as excludes foreign matter.

should have a backing plate to keep it in place and prevent creeping in its housing bore.

With reference to the sealing element itself, the first real seal produced was made from a heat and oil resisting tanned leather flange packing. It worked very well, especially on low speed mills that were grease lubricated. With the advent of higher speed mills using oil lubrications and alkaline coolants, leather began to lose out. The higher speed caused more frictional heat than the leather could stand. Alkaline coolants rotted the leather and when additives were put into the lubrication system to prevent emulsion with water, leather just couldn't do the work. Various composition sealing elements were tried but these were too hard to properly flex and they too failed, either through heat or chemical action. About this time synthetic rubber was developed and seal manufacturers started to use a compound of asbestos and synthetic rubber for the sealing element. The trouble here was that the oil caused the rubber to swell separating the bond with the asbestos fibre. The loose fibre wrapped around the shaft and started a cutting action. This combination material was discarded as unsatisfactory. At the present time, new developments in synthetic rubber compounding have made possible a straight synthetic rubber sealing element that is quite effective, which is shown in Figure 4. The lip of the seal is sharp and remains so. It is not attacked by grease, oil or water and when in operation in the presence of lubrication, causes very little friction or wear. Just to prove to yourself how little friction exists between rubber and a greasy surface, try walking on a mill floor covered with palm oil, wearing a pair of shoes with rubber heels. It is quite a job to keep from slipping, and that is just the way synthetic rubber seals work on lubricated shafts. Today, most all steel mill seals are made from synthetic rubber. It makes the most satisfactory sealing element for large size seals.

Figure 3 — The shaft seal has a sharp cutting edge which cuts the film and prevents it from moving past the seal.



We have followed the development of the sealing element material, so let us look at the design problem. As stated before, the seal must have a sharp wiping edge in contact with the shaft. If this shaft contact is too great the seal is starved for lubrication and both the seal and the shaft become worn. If the contact is too light a leak is easily developed. Most designs today use a flange made approximately $\frac{1}{8}$ in. under shaft size at the top and $\frac{1}{8}$ in. over at the bottom. The over and under dimensions vary with the shaft size. This tapered barrel when placed over the shaft allows for a ring contact as shown in Figure 5 of about $\frac{1}{8}$ in. to $\frac{3}{16}$ in. wide, which is very effective. In order to give maximum flexibility or following ability to this contact ring, the tapered barrel is molded somewhat thinner at the bottom and heavier at the top. The thin section allows for easy flexing while the thicker top portion adds strength and gives longer effective life. Still another design uses a flange barrel with a $\frac{1}{8}$ in. offset producing exactly a $\frac{1}{8}$ in. contact ring. This offset or limited contact design eventually flattens out and does not give quite as long effective service as the standard straight side wall flange design.

So far we have covered the shell, the material used in the sealing element, and its design. Now we will see how the whole is assembled into one unit. This can be accomplished in two ways. The synthetic rubber sealing flange may be clamped into its shell housing by use of an angular section metal ring, shown in Figure 6, or by use of a solid composition block, shown in Figure 7. The other method is to vulcanize it directly to the metal case, as shown in Figure 8. When clamping device is used there is some danger of the non-compressible rubber flowing from the point of pressure and distorting the shape of the sealing element, as illustrated in Figure 9. This is especially true in small size seals. Vulcanizing directly to the shell avoids this danger and assures the finished seal being exactly to the size and shape of the mold used in production. A seal may be perfect in design but unless it is made and held to exact specifications it will fail in performance.

In the definition of shaft type seals, the statement was made that the sealing edge must remain in constant contact with the shaft. This really is the important factor in seal operation. Every manufacturer uses a spring to accomplish this result. The springs are mostly

of the garter type, although one manufacturer uses a finger spring and has lately added a garter spring for good measure. The finger spring alone has never proved very effective. In the large sizes it was difficult to make them of one piece and almost impossible to reach the same temper in any two like springs. Part of this problem was solved by use of strip fingers layed around the sealing element but here, besides anchoring the seal to the shell, the spring too had to be held in place. The clamping method was all that was available and distortion mostly resulted. With the garter spring any tension desired was obtained without variation, while with the finger spring this was impossible. Today, all steel mill seals are produced with the garter spring with or without the addition of finger springs. Those seals using garter springs only use a heavy canvas cloth reinforcement directly under the spring on the sealing element to prevent any possibility of the spring cutting through the synthetic rubber. Where a combination of finger and garter springs is used the fingers give the same protection.

Springs keep the sealing element of the seal in constant contact with the shaft but this is not sufficient. The cutting edge must be held in place. This can only be accomplished by having this edge directly under the spring. By using what is called an inverted bevel cut on the top of the flange lip, the garter spring rides directly above the edge and gives the desired results. Should this edge be above the spring it will eventually curl away from the shaft and produce an effect known as bell mouthing, shown in Figure 10. A bell mouth seal offers a funnel opening to the material to be sealed and invites leakage. Just to prove how important a little thing like the correct location of the wiping edge may be, we can cite an actual case: A seal without the inverted bevel edge was installed and ran for three months with fair results then failed completely. The same constructed seal with only the addition of the inverted bevel was next installed and gave nine months' effective service.

With the properly designed and produced seal there is not much of a problem to achieve satisfactory sealing, provided the shaft runs true. This ideal condition is, however, seldom the case. Shaft bearings wear, and in the case of sleeve type or flood lubricated bearings, the clearance in new bearings is 0.001 in. for each inch of diameter. On a 30 in. shaft this would mean 0.030 in. It may go to as much as 0.070 in. before being replaced. In roller bearings, clearances may be as much as $\frac{1}{16}$ in. This clearance allows for much shaft eccentricity and the seal must be able to accommodate it. That is quite a job.

Another problem is shaft deflection. When a roll is under a heavy load there is considerable bending action and the seal must again be able to follow exactly. Just picture a large seal press fitted into a chock which means that it is absolutely stationary on the outside diameter of the metal case. Figure 11 shows that the neck of the roll is in place and the seal is making perfect continuous contact on this shaft. As the metal starts through the work roll let us assume that the backup roll moves upward as much as 0.040 in. The sealing lip and edge must follow and stay in contact. On one side this presents no problem, as the shaft is moving upward and carries the lip with it, but in the bottom an open

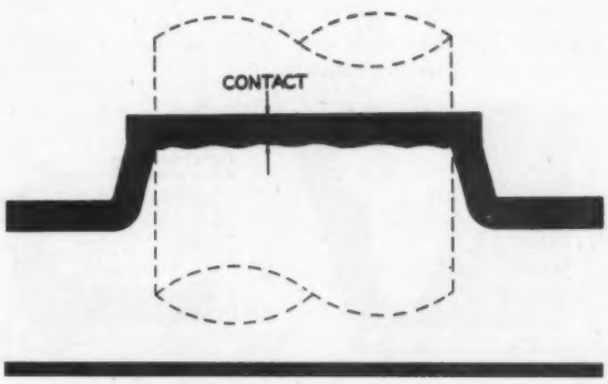
Figure 4 — Typical satisfactory synthetic rubber seal.

space would result were it not for the continuous garter spring. Pushing the spring upward on top pulls the bottom up too, providing the sides of the spring do not stretch. This brings up one more point on spring designs.

An effective garter spring must be wound with all possible initial tension. By initial tension is meant that the spring is stiff, each coil is layed tightly against its neighbor and resists being pulled apart. A high initial tension spring does not mean a tight spring, so that the pressure exerted on the sealing element is not much greater than were the seal assembled without any spring. The closer the spring approaches a solid steel ring the less the stretch and the more effective it becomes.

Seal manufacturers all have been greatly handicapped by steel mill machinery manufacturers who design and produce machines without regard for seal space. In many cases the space available to accommodate seals was so small that effective seals could not be made. Imagine a 40 in. roll neck with a movement of 0.060 in. sealed by a flange in a seal only $\frac{5}{8}$ in. wide. The total length of effective lever arm would be less than $\frac{1}{4}$ in. deducting for thickness of the sealing element and metal shell gauge. Many mill men have remachined their chocks, where possible, to secure more room for wider seals. Where sufficient room is available, seals have been designed with sealing elements $1\frac{1}{2}$ to 2 in. long equipped

Figure 5 — Sketch showing correct contact of flange on shaft.



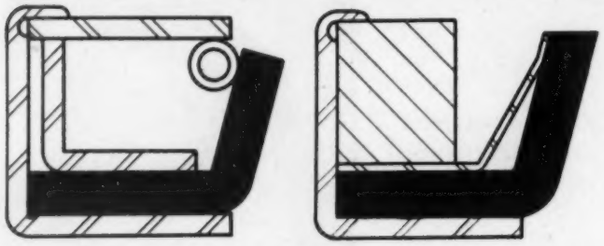


Figure 6 — (Left) Sealing flange clamped into shell housing with angular ring.

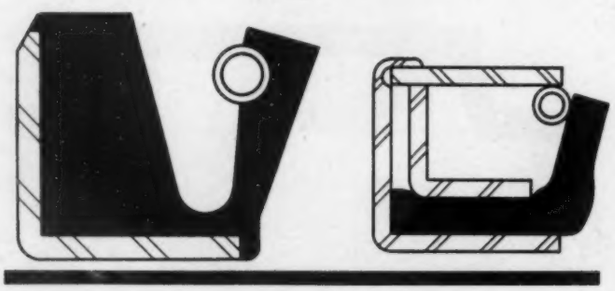
Figure 7 — (Right) Sealing flange clamped into shell housing with solid composition block.

with two parallel garter springs, as illustrated in Figure 12. The top spring holding the wiping edge in contact and the lower spring forcing the barrel of the flange to follow the movement of the shaft. Variations of up to ¼ in. on a side have been successfully sealed with such seals. Long neck seals have proved most satisfactory on temper and cold reduction work rolls. These work rolls eventually need rehardening and then require a regrind on the necks. A change in shaft size results, which the seal must accommodate. Long neck seals are designed to cover a wider shaft variation too; so if it is at all possible to machine the chock for this added width, it will pay dividends.

In seal applications on steel mills, many cases require that seals work in two directions; a seal is required to hold in the lubricant and also keep out the coolant. One seal cannot accomplish both jobs so two seals must be used, one having the sealing lip pointed toward the oil and the other faced toward the coolant. This application is known as double opposed construction. When two seals are applied in the same direction the design is known as double tandem. An example is shown in Figure 13. When double seals are applied, especially in tandem, it is very important that lubricants be introduced between the two sealing elements, the theory being that the first seal prevents any possible leakage, and as a result the second seal must depend on an outside source for lubrication, or burn up due to friction. Today, there are less and less double tandem seals used as one good seal is sufficient. Double seals formerly were made contained in a single shell. However, this practice necessitated removing both seals when

Figure 8 — (Left) Sealing flange can also be vulcanized directly to the metal case.

Figure 9 — (Right) With the clamping device, distortion can sometimes occur.



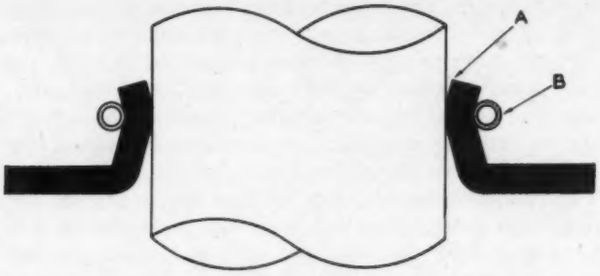


Figure 10 — A bell-mouthed flange cutting edge "A" has formed above the spring center "B."

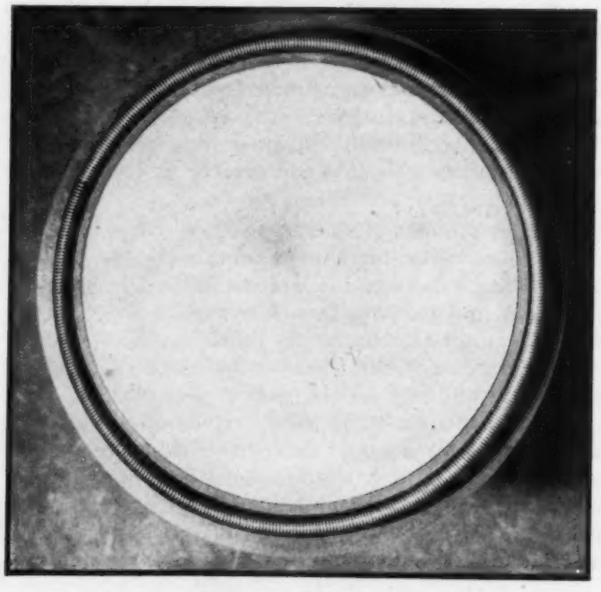
only one wore out. Now, it is considered good practice to produce all seals in single thicknesses which may be replaced individually or used singly. Single seals to be used in double applications are equipped with spacer lugs welded to the back of the containing shell. When the seals are pressed one on top of the other, these lugs provide a space for lubrication introduced from an outside source, which prevents friction and wear.

The foregoing just about covers the subject of shaft type steel mill seals. Before moving on, it might be well to list the important facts to remember:

1. *Shaft finish* — Have the shaft on which the seals operate polished as smooth as possible. Shaft finish has everything to do with effective life of a seal.

2. *Lubrication of sealing lip* — Lubricate the lip of the seal with grease or oil just before assembling — this is very important. If the seal runs dry for the first few minutes of operation great damage will be done. Greasing prevents this and aids in sliding the seal on to the roll neck or shaft.

Figure 11 — View of end of shaft showing contact with seal.



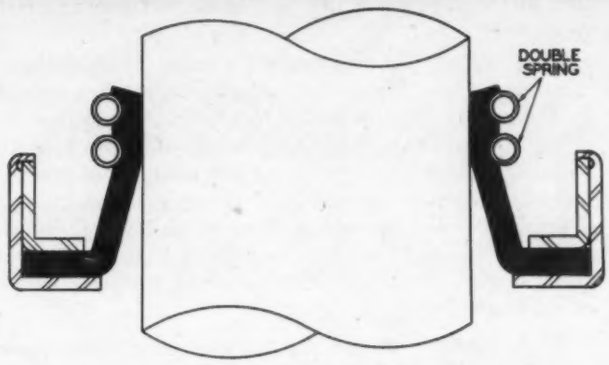


Figure 12 — This long lip seal has two garter springs.

3. *Proper press-fitting* — Press fit seal into housing bore very carefully, so as to prevent any possibility of cocking which will distort the seal and make it eccentric.

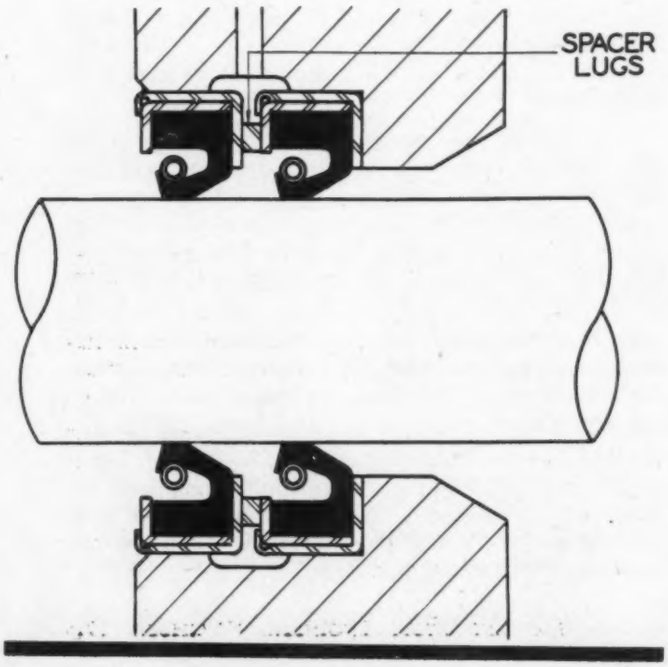
4. *Maximum space* — If possible, try to secure at least a one inch square cross section for seal room in the bore. Narrow seals are not too effective. Provide outside lubrication between seals used back to back, or in double reverse assembly. Seal surfaces must be adequately lubricated.

5. *Proper installation* — When shaft enters seal be sure not to damage the sealing lip. Some mills are using a hydraulic assembly table or rack to place the chocks on and off the roll necks. This device allows for perfect alignment. The end of the roll enters the chock and seal in concentric position. There is no chance of damaging the sealing lip.

6. *Test for seal leakage* — Tests for seal leakage may be made after the seal is in place in the chock. This is done by introducing a dummy roll neck, plugging all pipe lines and applying approximately 10 psi air pressure to the entire assembly. If the air pressure holds, the seal should prove satisfactory.

At the start of this paper mention was made of end face seals. An end face or surface seal is a self-contained metal encased unit consisting of a full floating sealing element or nosepiece, spring actuated with the exposed surface accurately lapped, locked against rotation and sealed in its housing shell by a suitable packing. The sealing element contacts a lapped rotating mating surface and sealing is accomplished by the tight contact of the two lapped surfaces, shown in Figure 14.

Figure 13 — This seal construction is known as double tandem.



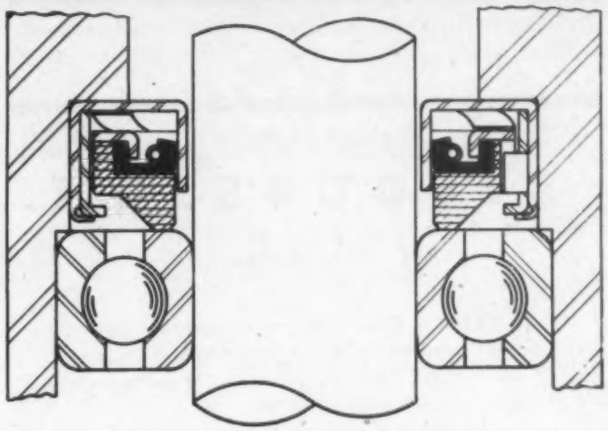


Figure 14 — Typical end face seal.

Steel mills use a form of this seal as a water guard. A ring of bakelite or leaded bronze is held against the end of the backup roll by means of a series of small coiled springs. The entire assembly is anchored to the chock by pins and is covered by a strip of leather of synthetic rubber wired in place. Water flowing over the rolls is prevented from entering the bearings by close contact of the sealed ring and the end face of the roll.

Seal manufacturers have long been aware of the principle of the end face seal and have done much work in perfecting the design. In small sizes surface seals are successfully used in machine tools, torque converters, hydraulic clutches and dirt excluding seals for bearings on crawler tractors. At present, experiments are being conducted on large sizes using meehanite against steel, special bronzes against steel, babbitt against steel, as well as many other combinations. After the proper pairing of metals has been determined, seal manufacturers are hopeful that mill machine manufacturers will cooperate for further development of surface seals.

It isn't at all impossible to conceive that a groove could be machined into the end of a roll body to accommodate a lapped mating ring embedded in synthetic rubber, which would rotate against a stationary sealing nose. The lapped surfaces could be made perfect, installation easy, costs reasonable, and the seal would run indefinitely.

An end face seal will successfully seal in both directions, exclude water and scale, and include lubrication. End play of the roll neck, misalignment, wobble, or any bending action will be easily handled while speed offers no difficulty. It is the ideal seal for this type of work.

With just a little cooperation of all concerned, the large size end face seal stands a good chance of becoming a reality. When this happens many mechanical problems will disappear. Oil leakage and water inclusion will be

a thing of the past and mill speeds may be increased to anything desired. All we need is a little patience and eventually there will be no more sealing problems.

DISCUSSION

PRESENTED BY

C. A. BAILEY, Special Engineer, Carnegie-Illinois Steel Corporation, Gary, Indiana

L. G. KRUG, Chicago Rawhide Manufacturing Company, Chicago, Illinois

R. A. KRAUS, Lubrication Engineer, Republic Steel Corporation, South Chicago, Illinois

C. E. PRITCHARD, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio

C. A. Bailey: In commenting on the paper entitled "Steel Mill Bearing Seals," it is timely to stress the importance of the subject in connection with mechanical maintenance and lubrication. There were three statements made that could well be called the law of seals:

1. Service life is a function of surface finish. The shaft on which the seal operates should be polished as smooth as possible.
2. Proper lubrication before and after installation. Damage to a seal by running dry the first few minutes of operation can be avoided.
3. Proper installation. Do not distort the seal during press fitting or damage sealing lip during installation.

In the early days of hot strip mills a test was conducted on backup roller bearing seals whereby it was attempted to recirculate grease through the bearings. Prior to this test, it was discovered that the scale contaminating the grease required frequent repacking of the bearing and if the lubricant could be purged and replaced with new grease the condition would be improved.

The test was not successful because the friction of the grease and bearing was greater than the resistance of the seal, resulting in the loss of lubricant through the seals. By investigating the cause of the problem rather than the effect, it is learned that if the seal had produced greater effectiveness it would have prevented the ingress of contaminates. Therefore, with sealing conditions as encountered in steel mills, the following question is directed to Mr. Krug: "Would it be possible to measure seal effectiveness by gauge pressure and, if so, what pressures might be expected on large diameter grease seals?"

L. G. Krug: One way of testing seals was to put them on a dummy chock set-up. This chock should be equipped with an air line so that approximately ten pounds of pressure could be applied. Several mills are testing in this manner at present. If the seal holds ten pounds of air for fifteen to twenty minutes, it should function satisfactorily on installation.

R. A. Kraus: I would just like to ask what shaft smoothness is economically recommended for seal contact surfaces. Is there any particular root mean square range desired?

L. G. Krug: If you can get a super finish surface, it would be fine. We do not want any scratches or tool marks left on the surface. A tool mark, if you can see it with the naked eye, is bad. You should get a smooth enough finish so if you run your nail over it you can not feel any ridges or irregularities. If you get that kind of a finish, it will not damage the seal and it will polish to an exceptionally smooth surface under the action of the seal itself. Try to get the smoothest surface possible at all times.

R. A. Kraus: Regarding the synthetic rubber type seal that you mentioned in your paper, what approximate temperature is recommended as an operating maximum and what temperature can be attained for short durations without appreciable damage?

L. G. Krug: Well, when we made leather seals and leather seals only, we knew 240 F was tops. Synthetic rubber will go higher than that. You could periodically go to 300 F without damage. I would say that you can safely go to 250 F without hurting anything, providing you have plenty of lubricant. You can go higher than that, but we would not recommend it.

You know, one of the men here spoke about a backup roll that had to be lubricated or should be lubricated, but they could not use grease or oil on it due to the leakage possibilities. He mentioned that the roll diameter in this case was about an inch or an inch and a half. I was just wondering, if it wouldn't be possible to use an end face seal on a job like that. On an inch and a half or two inch surfaces you can get an accurate lap. We can put an end face seal against that and hold pressure up to 50 or 75 pounds and with proper design, it can hold more than that. At present, there are some seals that hold 800 pounds of pressure and more, using this principle. With a balanced seal you do not have all the pressure acting on the nose so that it is possible to seal high pressure with low contact surface pressure. I think a lot of these applications, where you can not have any possibility of leakage, it would be possible to put an end face type of seal in place and get results.

C. E. Pritchard: What method is considered better from the standpoint of sealing, the usage of wide flanges and double garter spring, or the provision of the double opposed seal and single seal assembly as we have used in the past?

L. G. Krug: Your long neck seal will not seal in two directions anymore than the short one, but it will do a more effective job in sealing in one direction because it takes better care of the variations in the shaft deflection. If you are going to seal in two directions, you are still forced to use two seals. Long neck seals will work more satisfactorily.

C. E. Pritchard: What are the maximum limitations for seals subjected to high rpm and faulty operating conditions: (1) light load, (2) heavy load?

L. G. Krug: The load makes no difference because the seal operates effectively at low or high speed. Loads might tend to deflect the shaft so that a long neck seal would be recommended. As far as speeds go, we have made many tests and the maximum speed we can handle is 2000 feet per minute.

The Diesel-Electric Locomotive
IN STEEL PLANT SERVICE

. . . . some steel plants find diesel-electric locomotives costing $6 to $7 per engine-hour to operate versus $13 to $14 per hour for steam locomotives . . . . this is the compelling reason for the increasing use of diesel-electric in steel mill switching service . . . .

by J. W. Brauns

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

▲ AMONG the first to adopt the efficient, time- and labor-saving diesel-electric locomotive was the steel industry. These locomotives sold at $200 per horsepower in the twenties, and a few discerning pioneers saw their way clear to buy them and put them to work on steel-mill assignments. Even at the staggering prices of those days, it was a good investment; the units have now paid for themselves several times over. These early locomotives were fundamentally costly, because the engines, generators and motors revolved slowly compared to present-day standards; a lot of material rotated and reciprocated to produce tractive effort at the drawbar. However, these units had high availability and relatively low operating costs, and the steel industry took the diesel-electric idea seriously. The development for years was largely along the lines of big units; steam was used for the lighter jobs because there were no suitable diesel-electrics available.

In 1938, the small diesel-electric was developed with high-speed engines and electric drive, first as 20-ton locomotives with 150-horsepower, then 45- and 50-ton locomotives with 300-horsepower and at the astoundingly low price of $60 to $70 per horsepower. Again, with the same pioneering spirit of the twenties, the steel industry put them to work, and they soon proved their worth. Some troubles were experienced but corrected and these locomotives have paid for themselves long ago. Today the small diesel-electric has made a place for itself in this toughest of all industrial assignments, steel-mill switching.

The term "small diesel-electric" has come gradually to mean locomotives of 20 tons up to 80 tons as contrasted with "large" units of 100 tons and over which were developed primarily for class I railroad use. The performance of these "small" diesel-electrics, in a score of steel plants during the high pressure record breaking period of war production, has proved beyond doubt that, although they may be called "small," they are rugged and powerful.

The rapid increase in the use of the small diesel-electric is strong testimony of its ability to perform in steel-mill service. In 1940, the writer's company alone had five small diesel-electrics in the steel-mill industry, one 50 tonner for narrow gage, one 65 tonner, and three 80 tonners. As of July 1, 1945, five years later, this number had grown to 95 locomotives for operation in 45 different plants from New York to California, and from Illinois to Texas. These are divided roughly as follows:

17 standard 25-ton, 150-hp locomotives.
19 standard 45-ton, 300-hp locomotives.
8 standard 65-ton, 400-hp locomotives.
22 standard 80-ton, 500-hp locomotives.
5 standard 44-ton, 380-hp railroad-type locomotives.
10 standard 50-ton, 300-hp, 2-axle locomotives.
14 special locomotives ranging in size from 20-ton to 70-ton.

As the nomenclature would indicate, the majority of these locomotives are standard units designed for general-purpose industrial work. These standard locomotives are produced in large quantities, and, where applicable, give the most value for the money. In general, these locomotives have performed so well and proved to be such money savers that many steel companies are now buying special designs to meet their particular track gage, clearance, and load requirements that cannot be taken care of with a standard locomotive.

The 2-axle, 300-hp, 50-ton locomotive is a good example of a design that is tailored closely to meet the requirements of a specific job including the handling of

Presented before AISE Pittsburgh District Section Meeting, March 11, 1946

Sixty-five ton diesel-electrics are ideal for such services as hauling strings of charging buggies.

charging cars and ingot buggies between the scrap yard, open hearth, stripper, and soaking pits, and usually on narrow-gage track. This 50-ton locomotive has a ruggedly-constructed electric drive with ability to haul heavy loads.

For the benefit of those not thoroughly familiar with the basic make-up of a diesel-electric locomotive, its simple fundamentals will be briefly explained.

The basic prime mover is a diesel engine direct-connected to a direct-current generator. The engine delivers its mechanical power into the armature of the generator which converts this mechanical power into electric power in the form of electric current and voltage which are carried through cables to the traction motors which are geared to, and drive, the locomotive axles.

This conversion of mechanical to electrical power is a flexible and inherent transformation, and automatically adapts the engine output to the requirements of the load at any given moment. If the locomotive is moving slowly due to a heavy trailing load, the generator delivers high current at a low voltage which produces a high-tractive effort at a low speed.

As the locomotive speeds up, the generator inherently gradually raises the voltage and lowers the current thus maintaining constant load on the engine, protecting it against abusive stalling and loss of output, Thus, the generator becomes in effect a transmission of infinite ratios automatically shifting to the best ratio for the load conditions.

The engineer of the locomotive controls the power of the engines by one locomotive throttle handle which, when opened, closes the control circuits and power is gradually applied to the traction motors, thus giving smooth starting with quick response, and full horsepower is developed at all locomotive speeds which enables the diesel-electric to haul bigger loads and do more work in a given time. The diesel-electric has many money-saving advantages over steam locomotives, some of which are:

1. *Availability, better than* 90 *per cent* — The diesel-electric carries sufficient fuel for several days' operation, runs for long intervals between overhauls, and requires only short periodic inspections. Thus, it is available for work most of the time.

2. *Always ready to go* — The diesel-electric starts at the press of a button. No time is lost in getting the locomotive ready for work.

3. *Fuel costs low* — The diesel-electric's high efficiency allows it to operate on a fuel cost that is only a fraction of that of a steam locomotive. One gallon of fuel oil at 5 to 8 cents is equivalent to 100 to 125 pounds of coal at 12 to 30 cents.

4. *One-man operation* — The diesel-electric needs only a one-man crew, as against two usually required on a steam locomotive.

5. *Maintenance simplified* — The diesel-electric has no boiler firebox nor heavy reciprocating parts, thus greatly simplifying maintenance.

6. *Fire hazards reduced* — The diesel-electric gives off practically no smoke or harmful exhaust gas, and so it is ideal for use around or in buildings. When replacing a steamer, it lessens fire hazards and building maintenance.

7. *Track maintenance cut* — The diesel-electric is easy on the track because of the smooth, even tractive effort, low axle loading, and its short wheelbase.

Diesel-electric locomotives have been operating in steel mills long enough to get some good operating-cost data. The first diesel-electrics in operation have long ago paid for themselves, and when placed in service they will usually pay for themselves in two to three years. Both big and small steel plants have demonstrated by repeat orders that they find the diesel-electric an attractive investment. Since some of their operating experiences are very interesting, a few will be related here.

Mr. Charles E. Wickwire, president of Wickwire Brothers, Inc., says, "In December 1941 we obtained a 25-ton diesel-electric locomotive for general yard duty to replace an old 70-ton steamer.

"It has turned out to be one of the best investments in plant equipment that we have ever made, and most of the purchase price of the locomotive was saved in the first 18 months of operation. This saving was made principally in the reduction of fuel costs, track maintenance, repairs, and crew expense. Previously, we had used a 50-ton and a 70-ton steam locomotive. Now we do the entire job with the 25-ton diesel-electric locomotive which operates 24 hours a day. It handles general switching during the day, and switches the open hearth night and day. We kept the 50-ton steamer for stand-by, and have used it only six days in 18 months."

One large steel operator bought a 50-ton 2-axle locomotive in 1938, and has been getting additional units periodically ever since, until today he has a fleet of over 30 small diesel-electrics at his various steel plants. As his old steam locomotives wear out, he buys new diesel-electrics, and may become a 100 per cent diesel-electric operator eventually. Then he will realize additional large savings by the complete elimination of his steam facilities such as coal, ash handling, and watering equipment.

At another steel plant which uses 80-ton diesel-electrics, the master mechanic and the superintendent of motive power say, "These diesel-electrics are on the job 24 hours a day. Aside from regular inspections and general maintenance, they have not required any time out for service. The diesel-electric is the best motive power for the work we do. In the two years that we have had No. 310, it has saved us approximately 50 per cent of its cost by providing more switching per unit for less fuel, labor, and money."

And still another company, the Florence Pipe Foundry & Machine Company, Florence, New Jersey, purchased a 50-ton, 300-hp diesel-electric to replace a 55-ton, 3-axle steam locomotive to do the switching of all incoming and outgoing cars from the railroad, the intra-plant handling of all raw materials and finished products, and the dumping of slag in a dumping area which is about two miles distant from the plant. The locomotive works an average of 8 hours per day, 6 days per week, and its accomplishments have been summed up as follows:

1. Fuel costs have been cut 85 per cent.
2. Crew wages have been cut 33⅓ per cent.
3. Fueling time has been cut 87 per cent.
4. Locomotive availability thus far, 100 per cent.

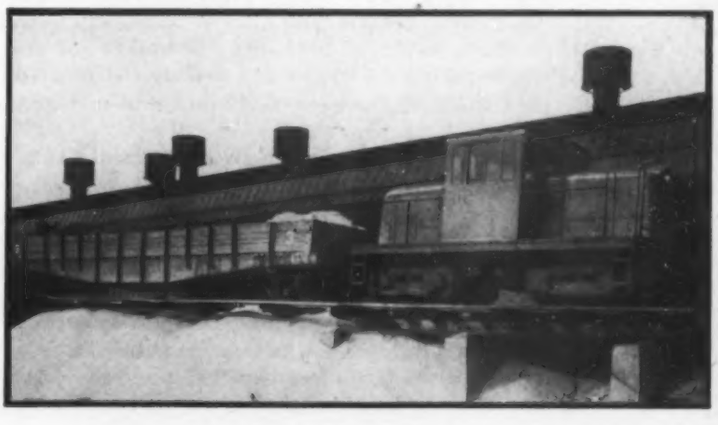
This particular installation dramatically emphasizes the high, smooth, tractive effort of the diesel-electric as one of its jobs is to push 80 tons of sand or coke up a loading trestle whose approaches combine an 8 per cent grade with a 400 ft radius curve at its immediate base. The 50-ton diesel-electric does this quite easily. The 55-ton steamer needed a long, fast, running start, and often required several tries. This method of operation spread the rails on the curve necessitating frequent rail maintenance and replacement at this point.

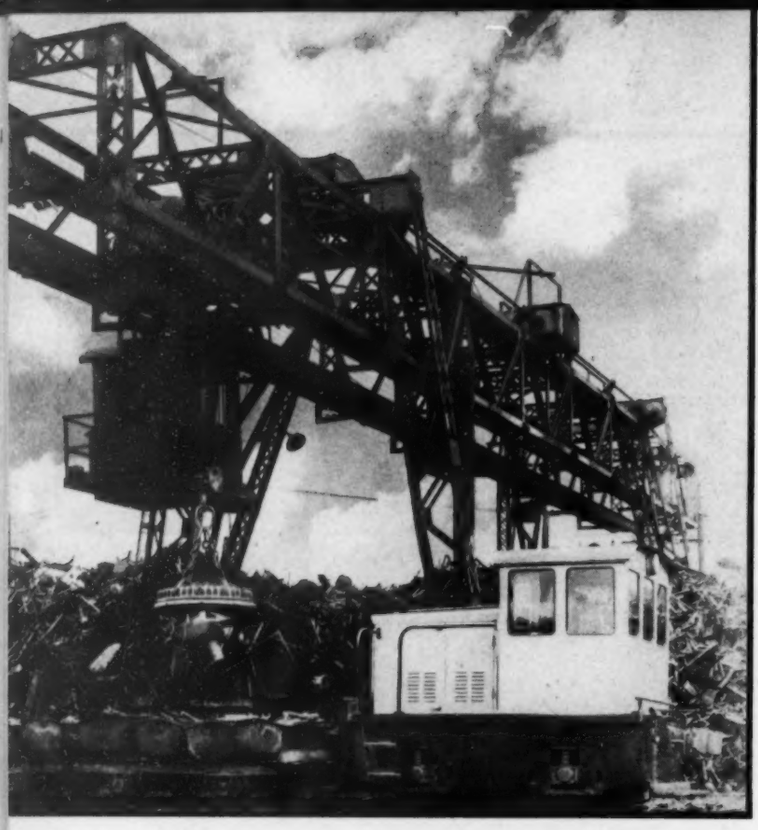
Sixty-five ton, 400 hp, 36 in. gauge, special locomotive built for use in one of the larger steel plants.

The experience of a midwestern steel-casting company which has been operating two standard diesel-electrics is interesting. In 1943, this company purchased a 50-ton diesel-electric. It proved satisfactory, and the next year a 65-ton unit was purchased. Up to the present, these two units have handled the work previously done by the three locomotives replaced.

The 50-ton locomotive switches charging buggies, and easily hauls up to 30 fully loaded cars. It operates 16 hours a day, six days a week. The 65-ton unit switches all incoming and outgoing railroad cars, be-

Diesel-electric locomotive, 45-ton, engaged in switching operation.





Twenty-five ton diesel-electric loading scrap into buggies in wire products plant.

sides doing intra-plant switching. It is busy 24 hours a day, six days a week.

In 1944, the 50-ton unit averaged 82 hours a week at a cost of approximately $4.31 an hour, including crew wages. From September to the end of 1944, the 65-ton unit averaged about 140 hours a week, at $4.26 an hour. The operating cost of each of the three steam units replaced was about $7.00 an hour, including crew wages.

The 50-ton locomotive, in a year and a half, 5620 hours, saved $15,000 of the purchase price, a return of 61 per cent on the investment in 18 months, or 41 per cent per year. If it continues operation at the weekly average of 82 hours, it will pay for itself in three years.

In the first 3½ months of operation, the 65-ton unit saved $5830. If operation continues at 140 hours a week, it will pay for itself in about two years.

By replacing two steam locomotives with two diesel-electrics, Copperweld Steel Company has reduced total switching costs $14 an hour. A 65-ton diesel-electric was placed in service in 1943, and a second 65-ton unit in 1944, replacing an 80-ton and a 40-ton steamer on the 16¼ miles of trackage at Copperweld's Warren, Ohio plant.

The steamers were costing between $13 and $14 per engine-hour to operate. The operating costs of the two diesel-electrics range from $6 to $7 per engine-hour. Thus the two replacements save a total of $14 per hour.

The diesel-electrics work 24 hours a day, 7 days a week, except for an 8-hour period once in two weeks, which is all the time required for inspection and maintenance. The track to the slag dump has a 2½ per cent grade for some 800 feet. Up this grade the diesel-electrics regularly haul trains of six 50-ton cars. In fact, so satisfactory has been their all-around performance that another steamer is being replaced by a third 65-ton diesel-electric locomotive.

To briefly sum up these operating experiences, the steel mills are saving money by using diesel-electrics to do their plant switching. No other type of motive power is available that will do the switching work as cheaply and as efficiently as the diesel-electric locomotive. A dollar invested in a diesel-electric is a dollar saved in two or three years. Even though labor and material costs are going up, the switching costs can be reduced by using modern diesel-electric switching locomotives.

DISCUSSION

PRESENTED BY

D. R. CAMPBELL, Transportation Application Engineer, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

J. W. BRAUNS, General Electric Company, Schenectady, New York

G. L. CAMPBELL, Assistant Manager, Service and Maintenance, Weirton Steel Company, Weirton, West Virginia

W. E. COX, Superintendent, Monongahela Connecting Railroad Company, Pittsburgh, Pennsylvania

T. J. JONES, Superintendent Transportation, Wheeling Steel Corporation, Steubenville, Ohio

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

HARRY CAMPBELL, Union Railroad Company, Pittsburgh, Pennsylvania

J. W. HOOVER, Assistant to Vice President in Charge of Operations, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

D. R. Campbell: I would like to ask one question, involving a unit not talked about. A 70-ton locomotive was recently announced, using high speed, axle hung, traction motors in which they departed from the usual custom of a relative low pitch for their gears, and I was wondering what their experience has been on that higher pitch gear?

J. W. Brauns: Yes, we have a new 70-ton locomotive, with the high pitch gearing. We have had considerable experience with this gearing, and as a matter of fact, these locomotives that I have been talking about have the double reduction gearing with about the same characteristics as the new 70-ton locomotive.

G. L. Campbell: Mr. Brauns said when they bring these locomotives in the shop you do not get smoke, but you do get a lot of fumes. I think they are as bad as the smoke.

J. W. Brauns: I suppose the diesel-electric engine does smoke a little bit, some smoke more than others, but so far as being objectionable is concerned, at least

it won't drive the men out of the shops. I know when I was doing the first testing of the high speed trains I almost had to live in the engine exhaust, but it is not nearly so objectionable as the steam locomotive exhaust.

W. E. Cox: Our experience with diesel locomotives has been favorable. While, our experience has been with a little heavier type of power than Mr. Brauns has been speaking of, I think our results fully substantiate most of the statements he has made on this type of power.

T. J. Jones: Our Wheeling Steel plant at Steubenville has a little heavier type, 115-ton, and we do have one 45-ton diesel-electric which has given us very satisfactory service. We think it is a good job. Of course, we see possibilities of one man operation with the lighter engine, but the heavier units might give a little difficulty on that score.

A. J. Fisher: I am quite pleased with the way the speaker handled the subject this evening, especially in regard to the nature of the exhaust of these diesel-electric engines. Being a fuel engineer, I can appreciate the value of not having any smoke around a steel plant. When photographers come to our plant they waste their time waiting for a steam locomotive to go by. Those engines put out a lot of nice colorful black smoke and they take the picture right then, with the plant in the background, and, of course for all practical purposes they have a nice high lighted smudge, it shows up well in the picture and they like it but I do not. It is a poor reflection of my work in keeping stacks from not smoking.

I am hoping for the days when we will have all diesel-electric locomotives and these photographers go home empty-handed.

Harry Campbell: We have, in all, 29 diesel locomotives. They are a little larger than those mentioned, our locomotives being 120-ton, 1000 horsepower jobs. I would like to see about three times that many on our road, that is how well I think of diesels. Perhaps some day we will have them, since I understand that operating and maintenance expense is less than for steam. They are giving us good service and stay in operation three to five twenty-four hour days without refueling, whereas the steamers require refueling about twice a day.

J. W. Hoover: I was very much struck by one thing Mr. Brauns said, and that was the reference to when the diesels were $200 a horsepower. I was very enthusiastic about them 20 years ago, and being somewhat of a callow youth, I tried to persuade our chief engineer to put one of them in the budget; I can still remember him looking over the top of his glasses and saying, "Where did you get the idea that $100,000 checks grew on peach trees?"

On the reduction of engine hour costs, Mr. Brauns really got someplace on that. Of course, some 20 or 25 years ago there was the reaction and expression from the crews that they "wore their feet down to the ankles" trying to follow the diesels; they didn't like them too well, they moved too fast, they reversed and got their tractive effort quickly and these boys had to move. I think they have accommodated the diesels to themselves, and not the reverse, and thus brought the diesel to their speed.

There is one thing I should like to ask. My appreciation of steel mill switching, in integrated steel plants, the average cars switched per engine-hour, would be from about two, which would be very low, up to about 3.50 loaded cars per engine-hour. Does anyone know or have any figures that would show what was the change, if any, in a complete change from steam over to diesel, and whether that showed up any better? Have you any experience or ideas? Of course, the figures would have to cover a complete elimination of steam and complete installation of diesel, otherwise they would not show a true picture. Does Mr. Brauns have anything on that?

J. W. Brauns: No, we have not kept any such records.

One thing we find is that customers buy the diesel-electrics and use them, but it is not necessary for them to keep detailed statistics on the locomotive. They know that the locomotive does work, that the locomotive itself may cost them $1.00 or $1.50 an hour to operate, whereas they estimate the steam locomotive at $4.00 or $5.00.

Member: I would like to ask if there is any advantage of a grounded system over an ungrounded system, if any?

J. W. Brauns: We can say it eliminates some wiring, thus it saves cable, but sometimes one operator may prefer the grounded system while another operator would not have it if you gave it to him. So it is mostly what the customers prefer. We have found from our own experience that the grounded system works out very well and it has certain small advantages. It does save some cable and reduces the cost of the cable installation.

Member: On those grounded systems where you have an engineer operating his locomotive with a heavy train and you are on high current, there may be a short and before the engineer knows what is going on, that short burns up the equipment. Whereas, if you have two wires you know what is occurring and can shut it off. So from my experience, the ungrounded system saves a lot of damage.

J. W. Brauns: That is true, but what we want to do on the small locomotives is give low cost with reasonable satisfaction, and from all my experience we have not had any cable burnout trouble on the small locomotives. We have eliminated some of the sources of trouble you might have on the two-wire system, where, for example, you have a contactor which, if it does not work properly, may cause trouble too. So the interest of economy is one reason we use the grounded circuit on the small diesel-electric locomotives.

Member: I would like to know if there is any information on the percentage of these locomotives supplied in the diesel-electric as compared to the straight mechanical?

J. W. Brauns: The mechanical started about the same time as the internal combustion, and I believe there are about 10,000 of these small mechanical locomotives now in service. We have no way of finding out the total number but we do know there is a large number of them. At the present time, the writer's company has shipped a little over 1000 small diesel-electric locomotives. We started in 1938. To my knowledge, a large majority of the locomotives purchased now are diesel-electric.

FUNDAMENTALS OF

Annealing Low Carbon Steel

. . . . presenting the results of experiments conducted at Case School of Applied Science under the sponsorship of the Lee Wilson Engineering Company . . . .

by G. Sachs[1], L. J. Ebert[2], G. B. Kasik[2], and J. F. Nejedlik[3]

CASE SCHOOL OF APPLIED SCIENCE

CLEVELAND, OHIO

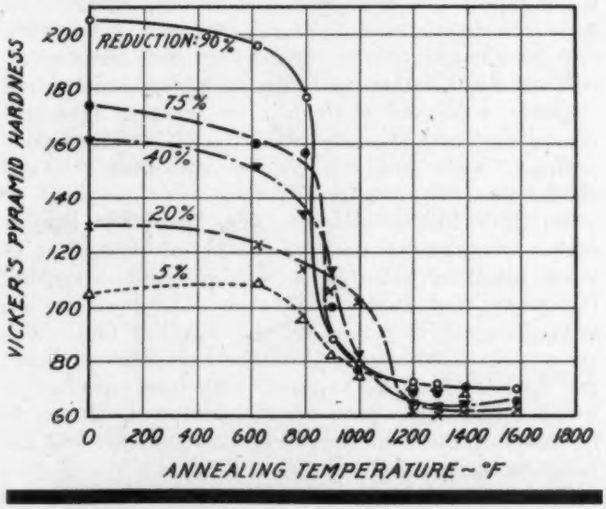
▲ IN the production of low carbon steel sheet and strip for commercial forming, the final annealing operation is rather critical, because it is one of the factors which primarily control the forming characteristics. The finished annealed product must possess maximum ductility to withstand the most severe draws to which it might be subjected. In order that the steel be annealed under conditions that yield optimum properties, a thorough knowledge of the basic relations between the properties and the annealing variables is necessary. The annealing operation performed in most commercial mills is the most time consuming single operation between casting the ingot and skin-rolling the finished strip. A reduction of the time required for the annealing has been found, therefore, to be highly desirable. Again the knowledge of the fundamentals involved in annealing is essential to decrease the time required for the annealing cycle.

Because of the importance of this problem from both quality and economy standpoints, a large amount of work has been done by many investigators on various phases of the subject. However, little data which are directly applicable to the problem of commercial annealing, are available on the fundamental relations involved. An extensive experimental study was therefore undertaken, to obtain a sufficiently complete picture of the factors which determine the properties of annealed, low carbon steel strip.

EFFECTS OF COLD WORK

The primary purpose of annealing is the elimination of the well known basic effects of cold working, i.e., the removal of the strain hardening and embrittlement induced by cold reducing the steel to the desired thickness. In the annealing process, the major portion of this softening is brought about by the process of recrystallization, or a formation of new grains. The major softening resulting from recrystallization occurs within a limited range of temperatures, shown in Figure 1, the values of which depend upon the amount of cold working for a given material. Figure 2 illustrates the effect of cold working on the recrystallization temperature of commercially pure iron (1)*, while Figure 3 shows the same effects for spheroidized SAE 1035 steel (2). The recrystallization of low carbon steel is governed by the same rules as that of any other metal. Thus, the recrystallization temperature is lowered with increasing amounts of cold work. The hardness of any annealed product is higher after recrystallization is

Figure 1 — Effect of the amount of cold-rolling on the recrystallization temperature of commercially pure iron reduced 5 to 90 per cent in thickness according to Austin, Luini, and Lindsay (1).



*Numbers in parentheses refer to the bibliography at the end of the paper.

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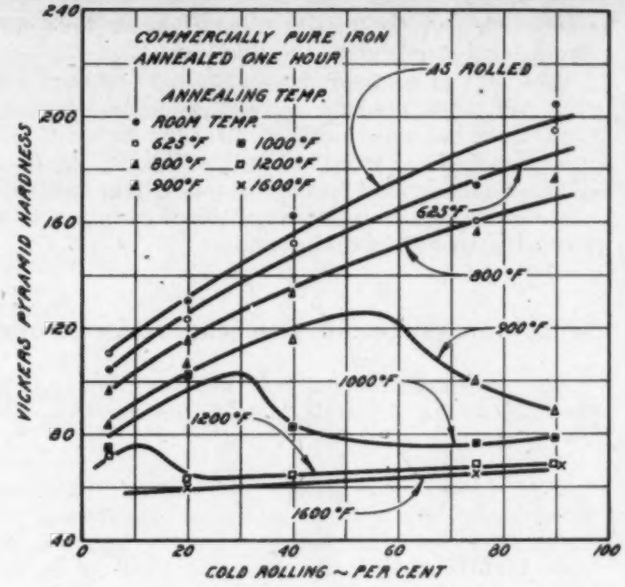
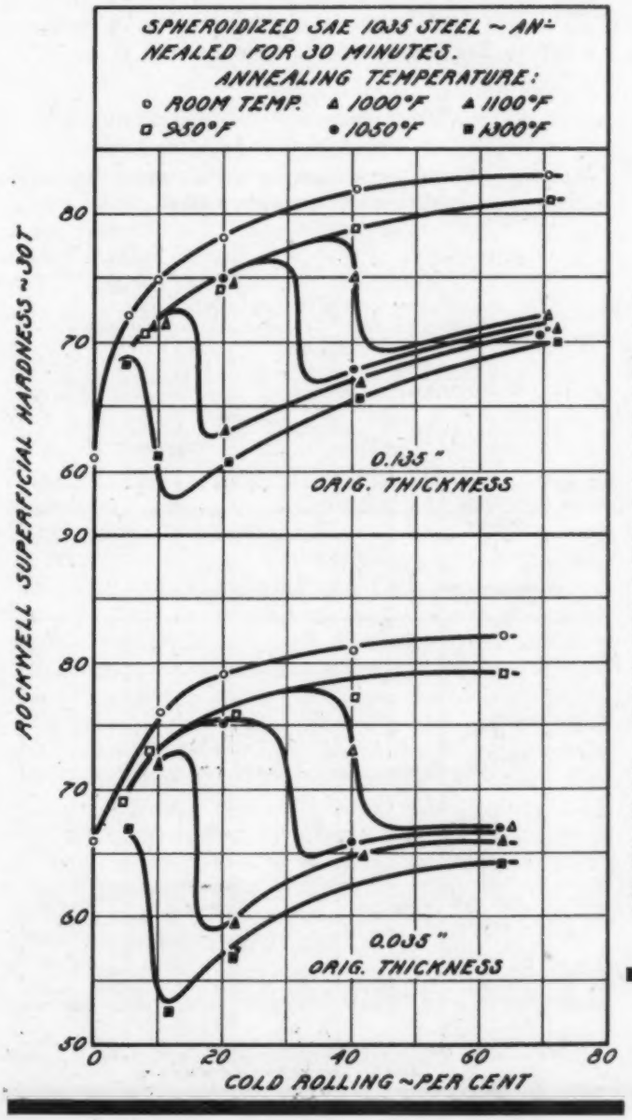


Figure 2 — Effect of degree of cold working and annealing temperature on the hardness of commercially pure iron according to Austin, Luini, and Lindsay (1).

Figure 3 — Effect of degree of cold working and annealing temperatures on the hardness of spheroidized SAE 1035 steel (Sachs and Thompson) (2).



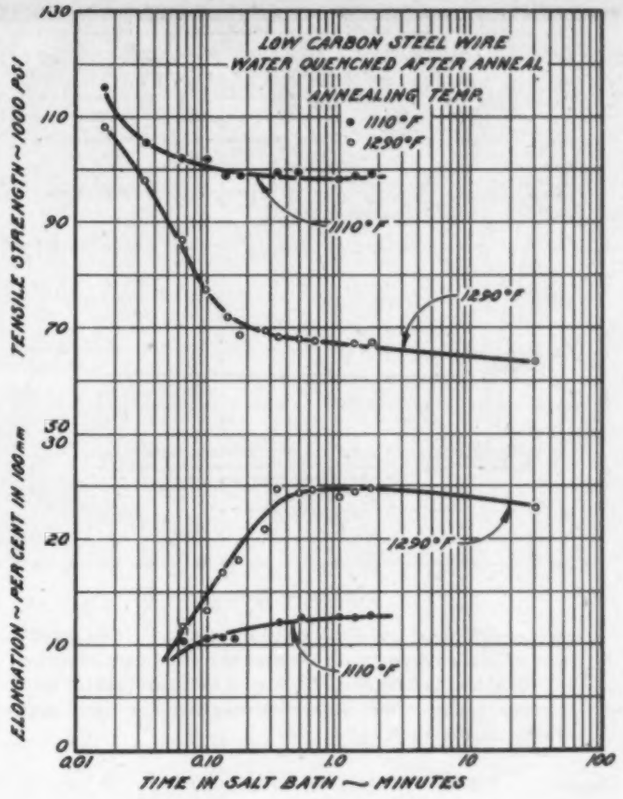
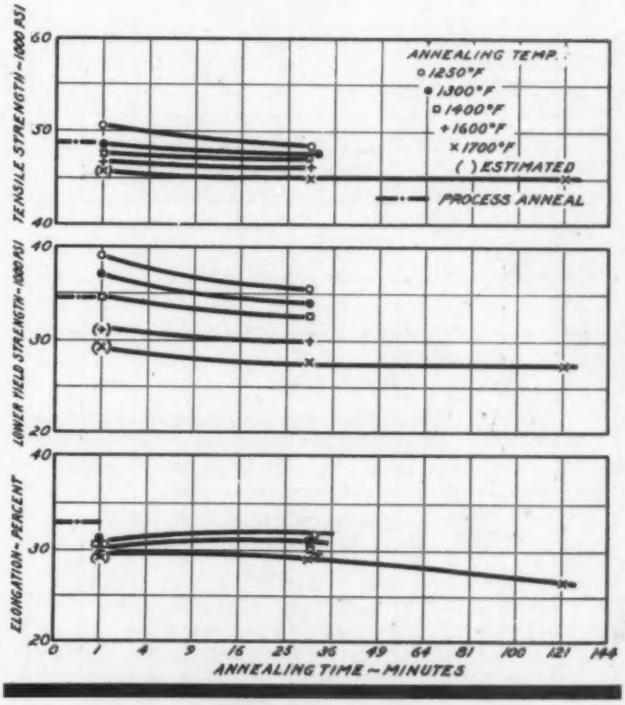


Figure 4 — Effect of annealing time on the properties of low carbon steel wire, 0.10 per cent carbon (Siebe) (3).

Figure 5 — Effect of annealing time on the properties of low carbon steel strip which is slow (furnace) cooled from the annealing temperature.



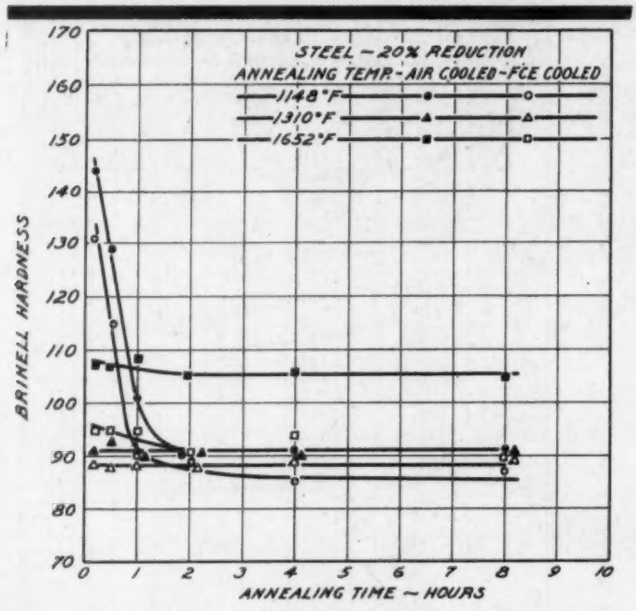
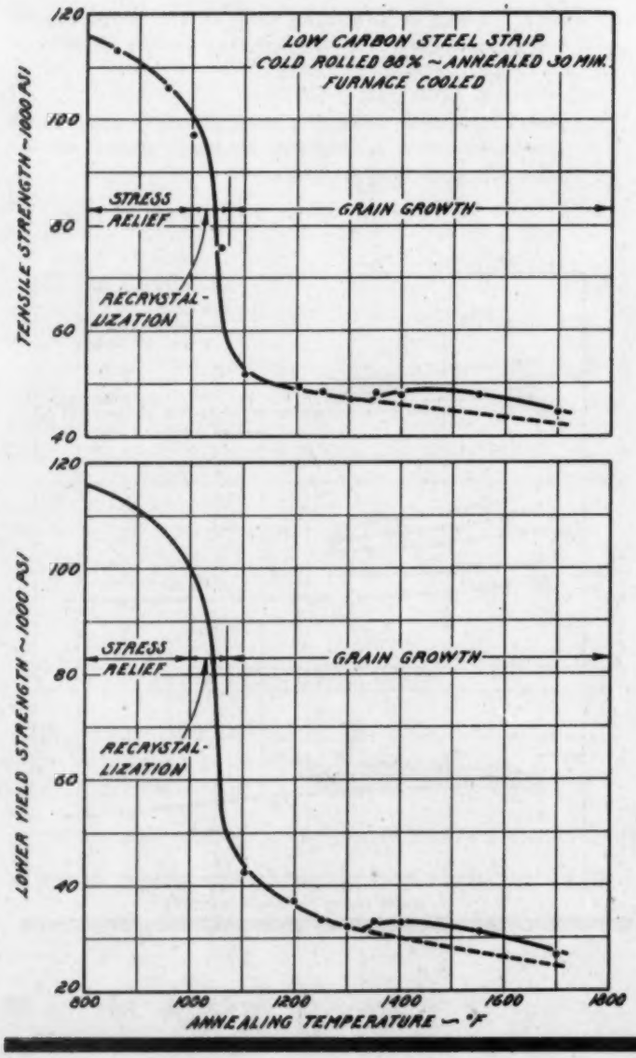


Figure 6 — Effect of annealing time on the Brinell hardness of low carbon steel, with percentage composition 0.08 C, 0.05 Si, 0.06 Mn, 0.005 P, 0.01 S; air-cooled and furnace cooled from several annealing temperatures (Pomp and Niebch) (6).

Figure 7 — Effect of annealing temperature on the tensile properties of rimmed low carbon steel.



completed, and the resulting grain size is finer for increasing amounts of cold work, Figure 1.

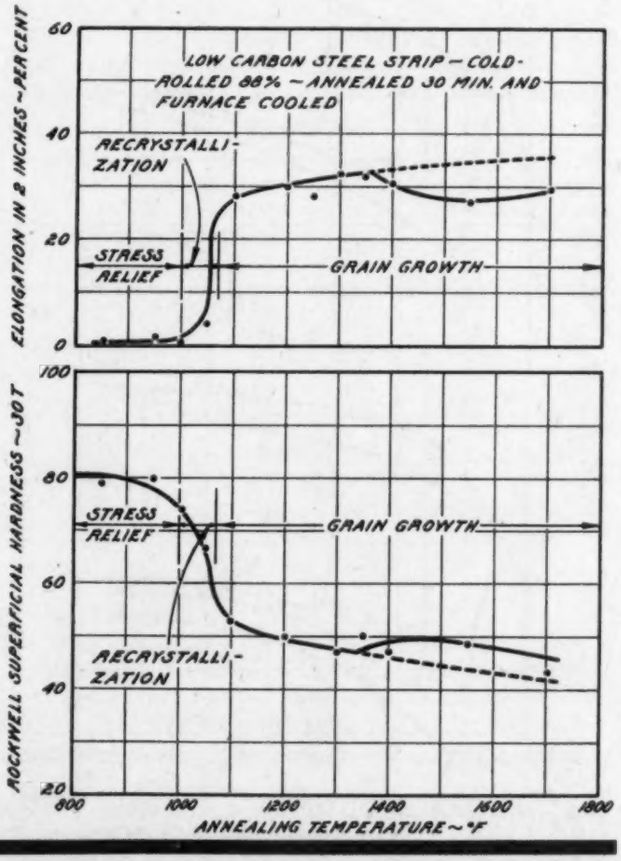
Annealing at temperatures above that necessary for recrystallization produces in most metals a comparatively small but important additional amount of softening because of the growth of the recrystallized grains. (The growth appears to have a rate which increases with decreasing size of the recrystallized grains, or with increasing amount of cold working.)

EFFECT OF ANNEALING TIME AND TEMPERATURE

The recrystallization of cold deformed grains is a function of both annealing time and temperature, the effects of which are closely related.

Cold worked steels become increasingly softer and more ductile with increased annealing time for a given annealing temperature and amount of cold work. In order that the effect of time alone may be discussed, all other factors must be held constant. In addition, the rate of cool and/or annealing temperature must be such that no complicating factors are encountered (discussed later). This effect is shown in Figure 4 for low carbon steel wire (3) and in Figure 5 for the rimmed steel strip used in the investigation. The steel used in the investigation was a rimmed steel 0.0098 in thick, cold rolled 88 per cent, with the following analysis in per cent: Carbon, 0.09; Manganese, 0.45; Phosphorus, 0.007; Sulfur, 0.026; Silicon, 0.003.

Figure 8 — Effect of annealing temperature on some properties of rimmed low carbon steel.


LOW CARBON STEEL STRIP – COLD-ROLLED 88% – ANNEALED 30 MIN. AND FURNACE COOLED
ELONGATION IN 2 INCHES – PER CENT
RECRYSTALLI-ZATION
STRESS RELIEF
GRAIN GROWTH
ROCKWELL SUPERFICIAL HARDNESS – 30T
ANNEALING TEMPERATURE – °F

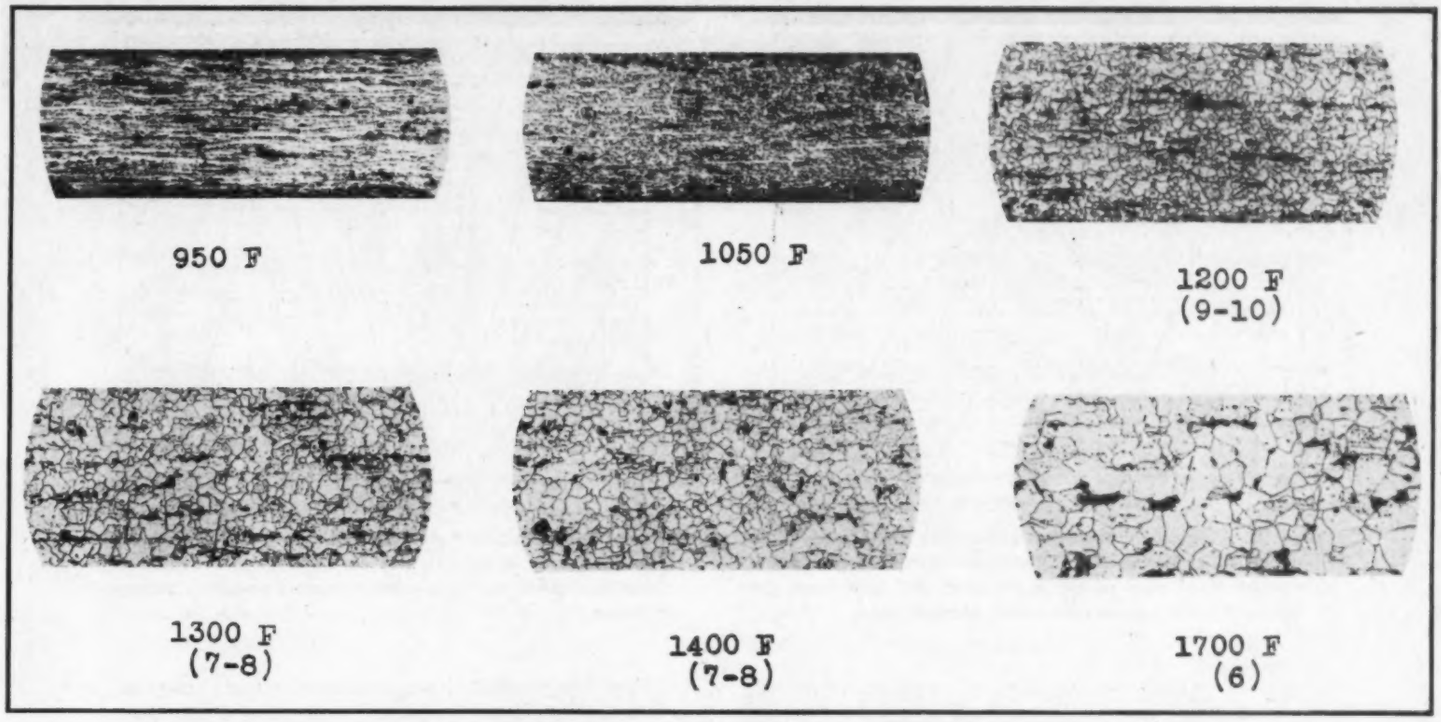


Figure 9 — Microphotographs (100X) show changes in grain size for rimmed low carbon steel strip annealed for 30 minutes at the indicated temperatures and furnace cooled to room temperature. The ASTM grain size numbers are given in parentheses.

A few check series of tests were made on other heats of rimmed steels, and the resulting data yielded curves whose trends were the same as the rimmed steel listed above. When short annealing times and variable cooling rates were studied, the steel was heated by resistance to the passage of electric current in a protective atmosphere, using a specially designed furnace in which the rate of heating, annealing time, and cooling rate could be varied and controlled accurately by manual control of the power input. For long annealing times, the steel was annealed in the conventional type electric laboratory furnace. In these cases, the steel strip was tightly wrapped in thin copper foil to prevent oxidation. The time required to soften a steel is a function of the annealing temperature, the hardening caused by cold working being completely removed after several hours at 1200 F, or in a few minutes at temperatures in the vicinity of 1300 F, or in a few seconds at temperatures around 1700 F (see later). The softening again progresses slightly when holding for longer times at temperature, but the major portion of the annealing effects occurs within the first two hours, as shown in Figure 6, (6).

In general, the rate of softening of a cold worked steel increases with increased annealing temperature for any given annealing time, provided that no complicating factors are present. Figures 7 and 8 present an example of the effect of annealing temperature on a rimmed steel, annealed 30 minutes (and furnace cooled to eliminate or minimize any hardening effects occurring on fast cooling, as will be discussed later). The curve defines three distinct regions:

1. The region between room temperature and about 1000 F, in which a slight amount of softening is obtained from relief of the residual stresses introduced on rolling.
2. The second region between 1000 and 1050 F, which is characterized by a sharp drop in hardness and strength associated with recrystallization, as discussed previously.
3. The third region beyond 1050 F. In this region a slight general decrease in hardness caused by grain growth is noted. The slight maximum in the curve at about 1375 F will be discussed later.

The grain sizes associated with the various regions of the curve for the steel discussed and shown in Figures 7 and 8 are exhibited in Figure 9.

As stated previously, annealing time and temperature are interrelated, since a cold worked steel becomes increasingly softer when either is increased. In Figures 10 and 11 this relation is represented graphically for a rimmed steel, cold rolled 88 per cent. The reversals of these curves at about 1330 F result from some incipient hardenability which will be described later. It can be seen that annealing time and temperature are interchangeable within certain limits, i. e., many combinations of time and temperature may be used to obtain a desired condition of strength (and ductility).

BASIC HARDENING EFFECTS

The foregoing discussion has considered only two factors involved in producing a certain desired softness in cold worked steel. This is the most general and lucid portion of the problem of annealing the low carbon steel. A much more complex portion of the problem deals with cooling by some suitable cycle to retain the

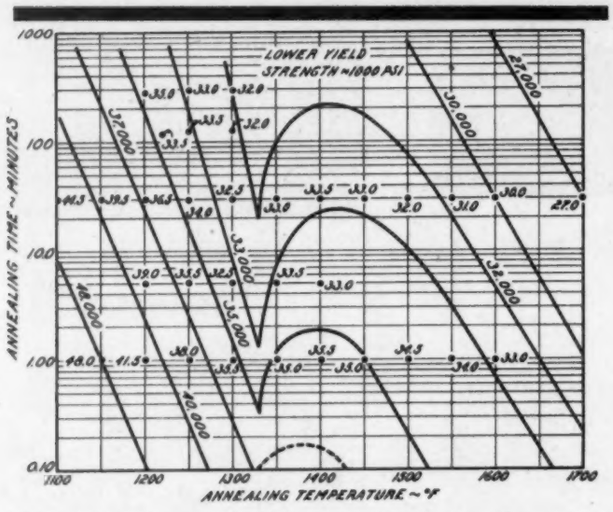


Figure 10 — Relation between annealing time and temperature as it affects the yield strength of rimmed low carbon steel, cold rolled 88 per cent. All specimens are furnace cooled from annealing temperature.

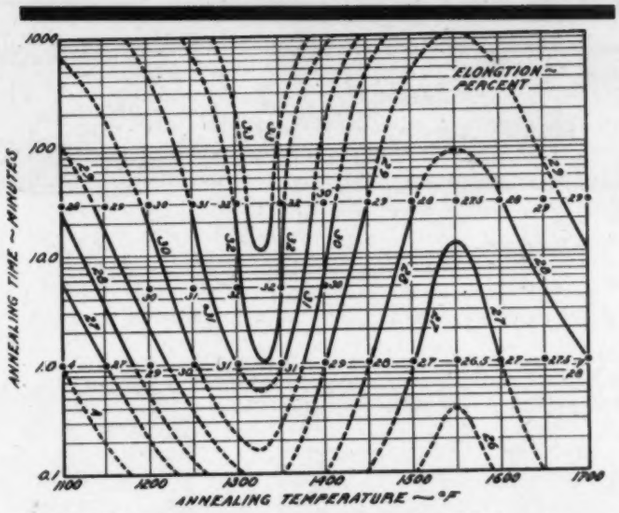


Figure 11 — Relation between annealing time and temperature as it affects the elongation of rimmed low carbon steel, furnace cooled from annealing temperature.

softness on cooling and on aging at room temperature. The previously discussed relations apply to furnace cooling or a very slow cooling rate. Whenever general terms are used for cooling rates, they refer to the rate of cool in degrees F per minute between the annealing temperature and 800 F. The various rates employed in this investigation are:

Furnace cooling, 1–10 F per minute.

Air cooling, 450–900 F per minute.

Forced air cooling, 2000–3000 F per minute.

Water quenching, greater than 7000 F per minute. More rapid cooling rates introduce certain hardening phenomena which masks the effects of annealing time and temperature. However, if the short annealing cycle is desired, some more rapid cooling rate must be employed. To develop such a cycle, a complete understanding of the fundamentals involved in cooling low carbon steel is imperative.

A consideration of the portion of the iron-carbon equilibrium diagram relative to low carbon steels, i.e., to carbon contents up to 0.15 per cent, Figure 12, leads to the observation that there are two important metallurgical phase changes to be taken into account in the annealing of low carbon steel. The first of these is the gamma-alpha transformation, or the reversible change of austenite (gamma iron) to ferrite (alpha iron) and pearlite (or to martensite on very rapid cooling). The second of these is the change in solubility with temperature of carbon or cementite (Fe_3C) in ferrite.

In the annealing of medium and high carbon steels, the first of these phenomena (gamma-alpha transformation) is the more important, while the variable solubility of iron carbide in ferrite has relatively little effect. However, in the annealing of low carbon steel with about 0.10 per cent carbon, for example, the variation of the solubility of carbon (carbide) in ferrite from about 0.04 per cent at the A_1 temperature (1330 F) to less than 0.01 per cent at room temperature becomes equally important as the gamma-alpha transformation.

From this consideration of the iron-carbon equilibrium diagram, it can be concluded that the possibility exists of developing three hardening effects on cooling a low carbon steel from the annealing temperature. While two of these effects are structurally correlated, they are sufficiently independent to be considered separately here. These effects can best be seen by taking the example of a low carbon steel annealed at some temperature above the A_1 temperature (1330 F) for a time sufficiently long to cause complete recrystallization, or softening. The first of the hardening effects to be encountered occurs on cooling to a temperature below the lower critical (A_1), or approximately 1330 F, Figure 12. At this temperature, the gamma-alpha transformation results in a change of the grain structure and size. If the cooling rate is sufficiently rapid, the new grains may be very small, and their shape and arrangement may be acicular or similar to martensite. This change in grain size is correlated with a hardening effect, and has been shown to occur even in chemically pure iron (4). The effect increases rapidly with the addition of increasing amounts of carbon, the major change taking place in the range of low carbon steels (5). For the sake of convenience, this effect may be termed hardenability effect.

The second hardening effect which might be encountered occurs on cooling from 1330 F to room temperature. Because of the decrease in solubility of the carbide in alpha iron, a supersaturated solid solution of carbide in ferrite may be retained with a resulting increase in hardness. This effect has been designated as solid solution effect.

The third hardening effect occurs after the steel has been cooled to a comparatively low temperature. It results from the instability of the supersaturated solid solution formed on rapid cooling. This effect has been termed quench aging effect.

All three of these hardening effects may be additive, under certain combinations of annealing temperature, cooling rates and aging time.

These three hardening effects are shown quantitatively for a rimmed low carbon steel containing 0.09 per cent carbon, in Figures 13 and 14. Here the steel was

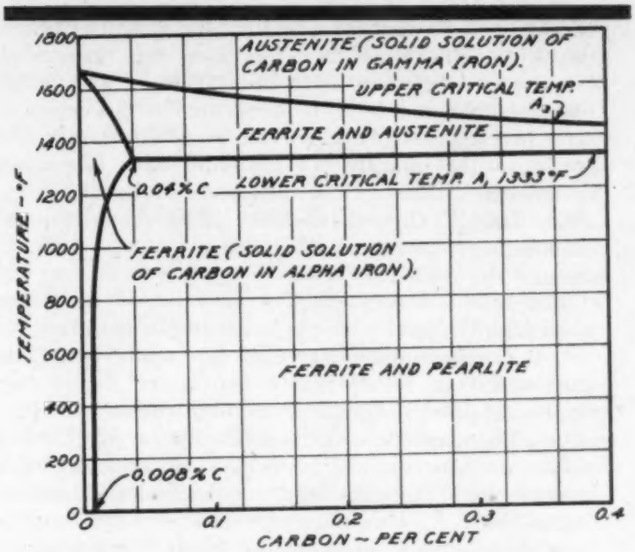
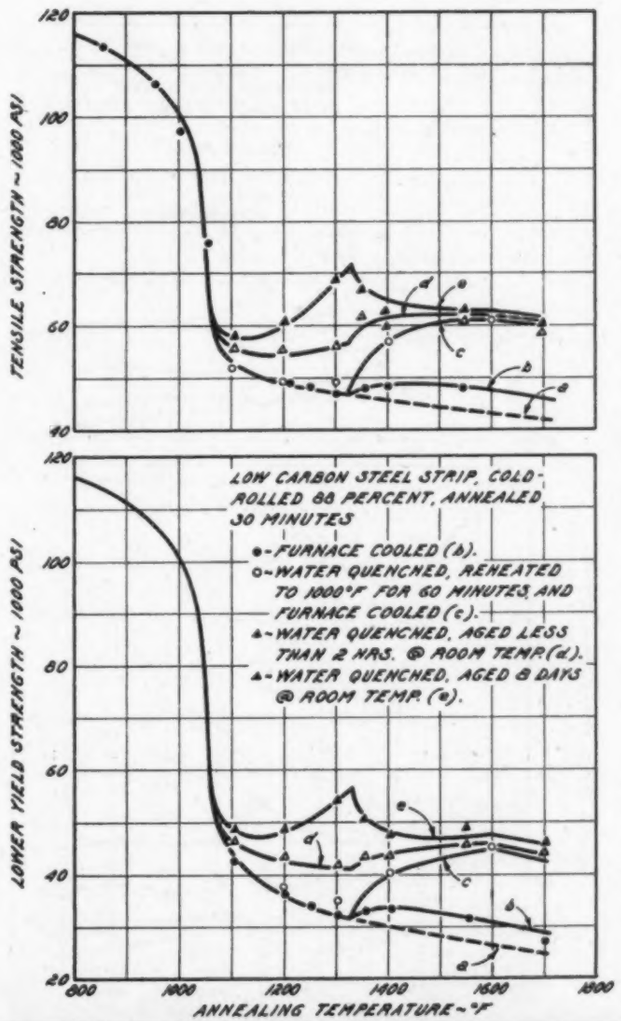

AUSTENITE (SOLID SOLUTION OF CARBON IN GAMMA IRON).
UPPER CRITICAL TEMP. A3
FERRITE AND AUSTENITE
0.04% C
LOWER CRITICAL TEMP. A1 1333°F
FERRITE (SOLID SOLUTION OF CARBON IN ALPHA IRON).
FERRITE AND PEARLITE
0.008% C
TEMPERATURE ~ °F
CARBON ~ PER CENT

Figure 12 — Portion of iron-carbon equilibrium diagram showing constituents present in low carbon steel at various temperatures.

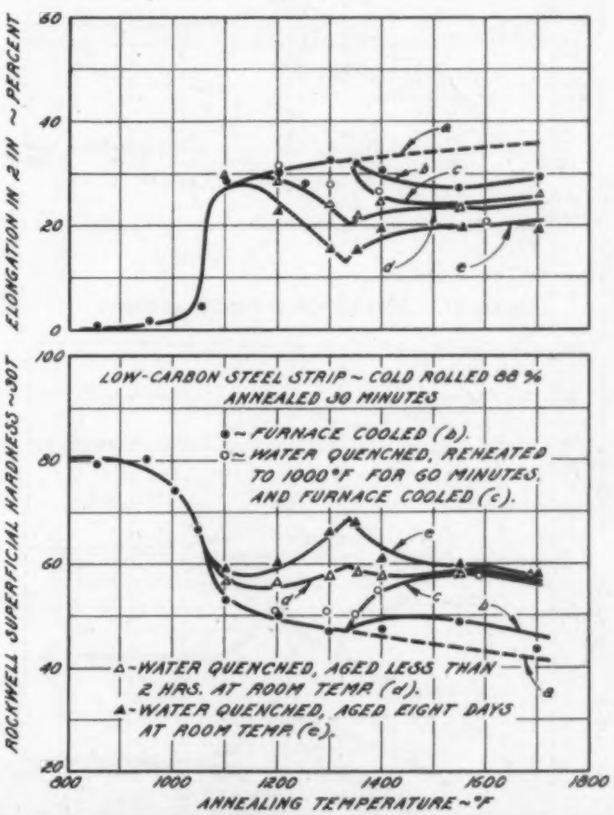
Figure 13 — Effect of annealing temperature and cooling rate on the properties of rimmed low-carbon steel.


TENSILE STRENGTH ~ 1000 PSI
LOW CARBON STEEL STRIP, COLD-ROLLED 88 PERCENT, ANNEALED 30 MINUTES
●-FURNACE COOLED (b).
○-WATER QUENCHED, REHEATED TO 1000°F FOR 60 MINUTES, AND FURNACE COOLED (c).
▲-WATER QUENCHED, AGED LESS THAN 2 HRS. @ ROOM TEMP. (d).
▲-WATER QUENCHED, AGED 8 DAYS @ ROOM TEMP. (e).
LOWER YIELD STRENGTH ~ 1000 PSI
ANNEALING TEMPERATURE ~ °F

annealed for 30 minutes at various temperatures and cooled at various rates and tested at different times. The basic properties obtained in the absence of, or at the minimum in, all three hardening effects are determined by furnace cooling. It was found that at this rate of cool the solid solution and quench aging effects were absent, and the hardenability effect was at a very low minimum. The slight maximum in this experimental curve of the basic properties between 1330 and 1450 F may be attributed to some residual hardenability which might perhaps be removed only by some cooling rate slower than that obtained in the furnace cool utilized. This residual hardenability was established only after numerous and very accurate tests to completely eliminate the experimental scattering. However, since this retained effect was so small (and was definitely recognized as a hardenability effect), no attempts were made to eliminate it. The true basic curve was interpolated in this region.

The hardenability effect was determined by water quenching the steel from the annealing temperature, to obtain maximum hardenability, and then reheating to 1000 F followed by furnace cooling. This procedure was found to eliminate both the solid solution and the resulting aging effect, but to affect the hardenability effect only slightly, for a low carbon steel. The hardenability effect then is the difference between the properties resulting from quenching and tempering and those given by the basic curve. This difference is shown in Figure 15. As would be expected, the hardenability

Figure 14 — Effect of annealing temperature and cooling rate on the properties of rimmed low carbon steel.


ELONGATION IN 2 IN ~ PERCENT
LOW-CARBON STEEL STRIP ~ COLD ROLLED 88 % ANNEALED 30 MINUTES
●~FURNACE COOLED (b).
○~WATER QUENCHED, REHEATED TO 1000°F FOR 60 MINUTES, AND FURNACE COOLED (c).
△-WATER QUENCHED, AGED LESS THAN 2 HRS. AT ROOM TEMP. (d).
▲-WATER QUENCHED, AGED EIGHT DAYS AT ROOM TEMP. (e).
ROCKWELL SUPERFICIAL HARDNESS ~ 30T
ANNEALING TEMPERATURE ~ °F

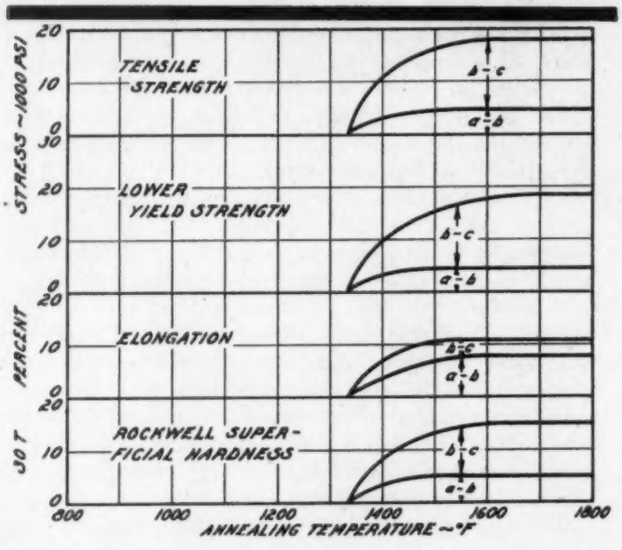


Figure 15 — Magnitude of the hardenability effect showing incipient hardenability (a-b) and quench hardenability (b-c).

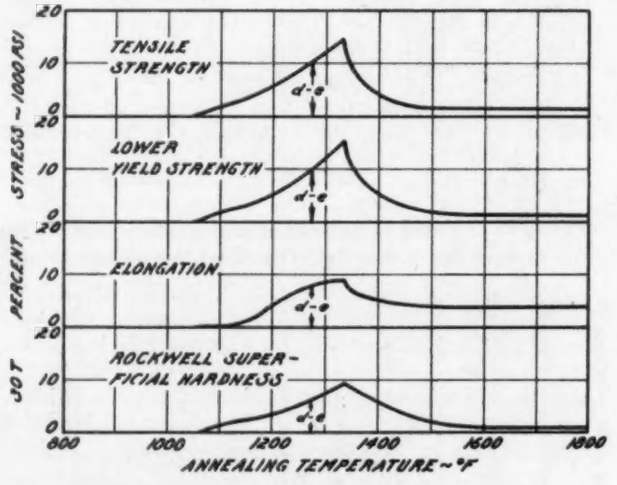
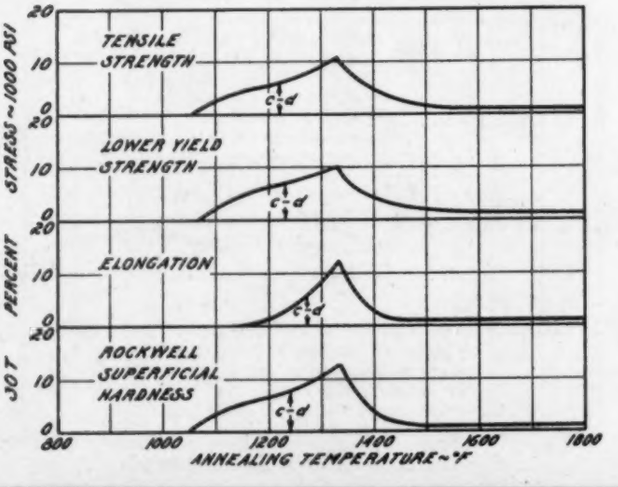


Figure 16 — Magnitude of solid solution effect.

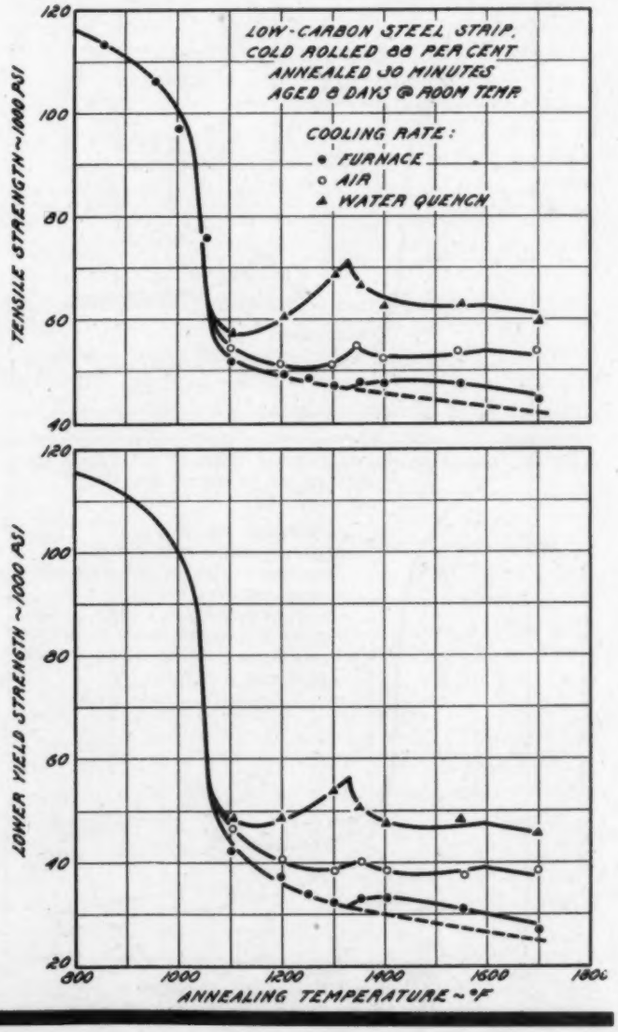
Figure 17 — Magnitude of the aging effect.



effect is non-existent for annealing temperatures below the A_1 (1330 F). It then increases with increasing temperature between 1330 and 1600 F, the latter temperature being the A_3 temperature for the particular steel investigated. This increase results from the increase in the quantity of austenite with increasing temperature. Although not determined for temperatures above 1600 F, the hardenability effect should remain essentially constant in this range of temperatures because the steel would be entirely austenitic.

The solid solution effect was evaluated by water quenching the steel from the annealing temperature, to obtain the maximum degree of supersaturation. The steel was then tested within two hours, before any significant precipitation occurred to introduce the aging effect. The magnitude of the solid solution effect is the difference between the properties obtained by this treatment and those obtained on quenching and tempering at 1000 F. This difference is shown for various annealing temperatures for the steel investigated in Figure 16. In general, the difference reflects the solubility of carbide in ferrite and austenite, becoming a

Figure 18 — Effect of annealing temperature and various cooling rates on some properties of rimmed low carbon steel.



maximum at the temperature of the A_1 where maximum solubility is obtained. For temperatures above and below the A_1, the solubility of the carbide in austenite and ferrite, respectively, decreases, as does the solid solution effect.

Finally, the aging effect was obtained by permitting the water quenched steel to age eight days at room temperature. This effect is measured, e. g., by the increase in hardening which developed over the same steel tested immediately after quenching. This difference is shown in Figure 17, and follows the same trend as the solid solution effect from which it results.

It was also noted that if a rate of cool, intermediate between furnace cooling and water quenching, (i. e., air cooling) was employed, all three hardening effects occurred, but that their magnitude was reduced. Figures 18 and 19 show the composite effect of all three factors obtained on air cooling, as compared with those obtained on furnace and water quenching. Furthermore, it appears that, on air cooling, the solid solution and aging effects may occur simultaneously, since the steel usually was found to be stable at room temperature when this rate of cool was used.

EFFECT OF COOLING RATE

Examination of the iron-carbon equilibrium diagram, Figure 12, will indicate that the major change in solid solubility of iron carbide in ferrite occurs between 1330 and 800 F. Consequently, only a very small portion of the hardening caused by the solid solution and aging effects should be obtained on rapid cooling from any temperature up to 800 F. This is shown from the curves in Figure 20 in which the properties of a process annealed material reheated to various temperatures and water quenched are represented. Hardening (because of the solid solution and aging effects) was noted only when the reheating temperature exceeded 800 F.

Therefore, to eliminate the solid solution and aging effects, the rate of cool must be sufficiently slow to 800 F to prevent the formation of a supersaturated solid solution. This rate was found to be approximately 100 F per minute, according to Figure 21. In this graph, the properties of low carbon steel annealed 30 minutes at about 1300 F and cooled at various rates to 800 F are compared with the properties of the same steel obtained by a standard commercial process anneal. The hardening effects were considered to be eliminated when the prop-

Figure 19 — Effect of annealing temperature and various cooling rates on some properties of rimmed low carbon steel.

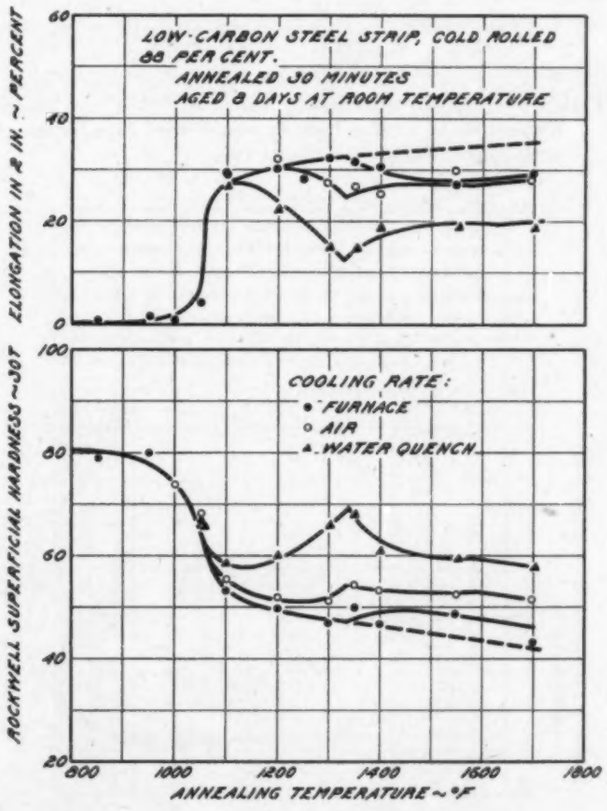
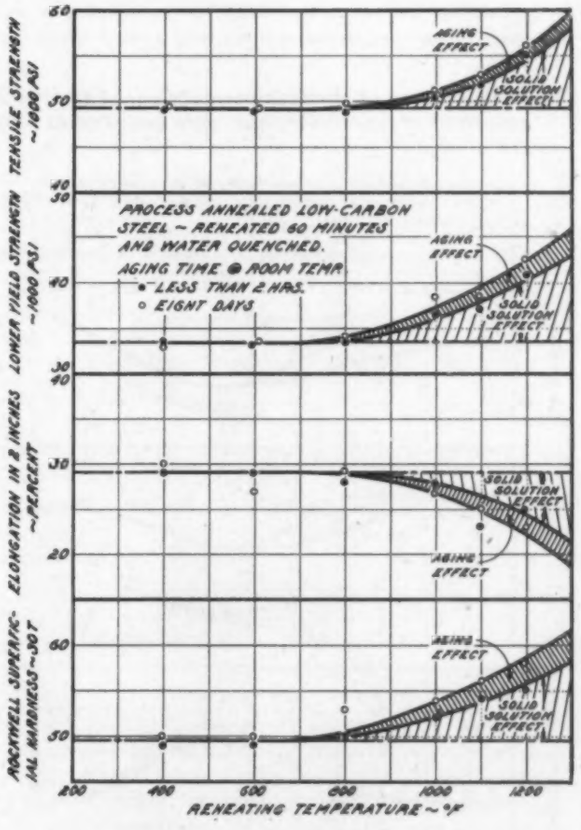

LOW-CARBON STEEL STRIP, COLD ROLLED 88 PER CENT.
ANNEALED 30 MINUTES
AGED 8 DAYS AT ROOM TEMPERATURE
ELONGATION IN 2 IN. ~ PERCENT
COOLING RATE:
• FURNACE
○ AIR
▲ WATER QUENCH
ROCKWELL SUPERFICIAL HARDNESS ~30T
ANNEALING TEMPERATURE ~ °F

Figure 20 — Effect of reheating and water quenching on the properties of process annealed rimmed low carbon steel.


AGING EFFECT
SOLID SOLUTION EFFECT
PROCESS ANNEALED LOW-CARBON STEEL ~ REHEATED 60 MINUTES AND WATER QUENCHED.
AGING TIME @ ROOM TEMP.
• LESS THAN 2 HRS.
○ EIGHT DAYS
TENSILE STRENGTH ~1000 PSI
LOWER YIELD STRENGTH ~1000 PSI
ELONGATION IN 2 INCHES ~PERCENT
ROCKWELL SUPERFICIAL HARDNESS ~30T
REHEATING TEMPERATURE ~ °F

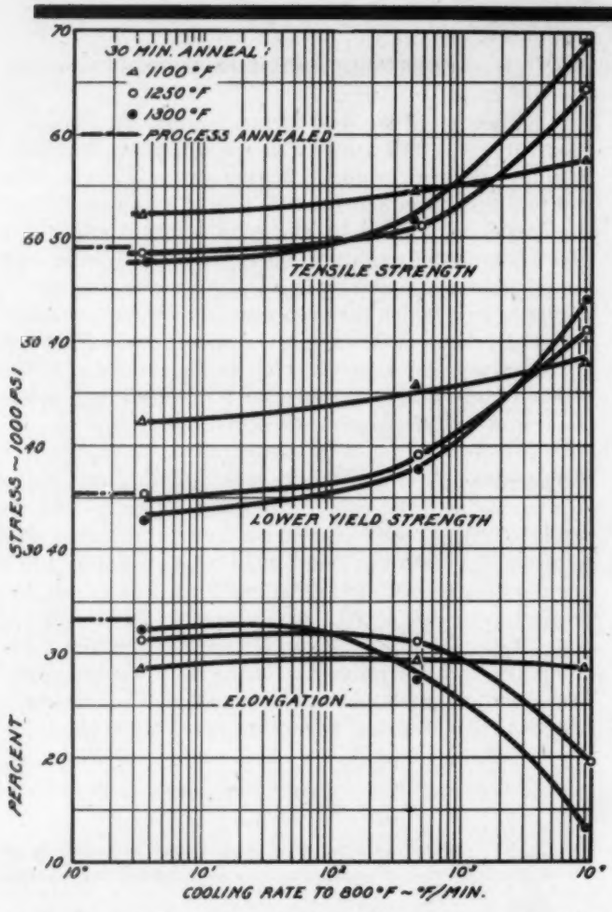


Figure 21 — Effect of cooling rate on the mechanical properties of low carbon steel strip annealed 30 minutes at various temperatures and tested after eight days.

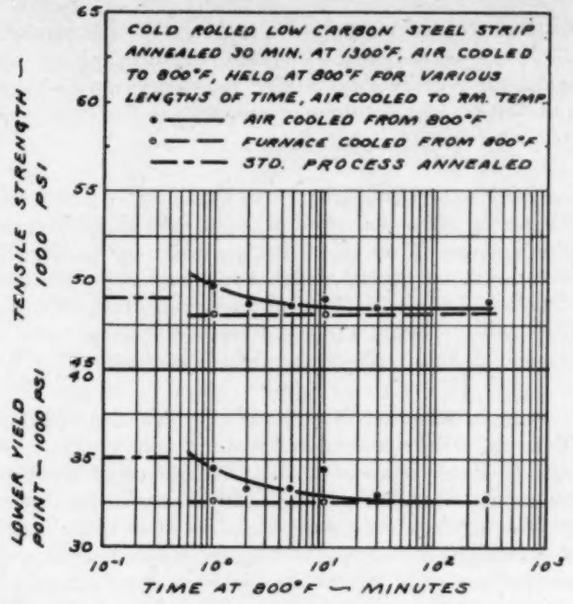

COLD ROLLED LOW CARBON STEEL STRIP ANNEALED 30 MIN. AT 1300°F, AIR COOLED TO 800°F, HELD AT 800°F FOR VARIOUS LENGTHS OF TIME, AIR COOLED TO RM. TEMP.
AIR COOLED FROM 800°F
FURNACE COOLED FROM 800°F
STD. PROCESS ANNEALED
TENSILE STRENGTH ~ 1000 PSI
LOWER YIELD POINT ~ 1000 PSI
TIME AT 800°F ~ MINUTES

Figure 23 — Effect of holding time at 800 F on some properties of cold rolled, rimmed, low carbon steel strip, annealed 30 minutes at 1300 F.

rties were the same as those of the same material obtained with a standard process anneal.

The solid solution and aging effects might alternatively be eliminated by a tempering treatment at some (shelf) temperature intermediate between 1300 F and room temperature. This treatment might consist of an interruption of the cooling cycle at some temperature for a given length of time (horizontal shelf) or of the

Figure 22 — Effect of shelf temperature on the mechanical properties of low carbon steel strip annealed at 1250 F and at 1300 F.

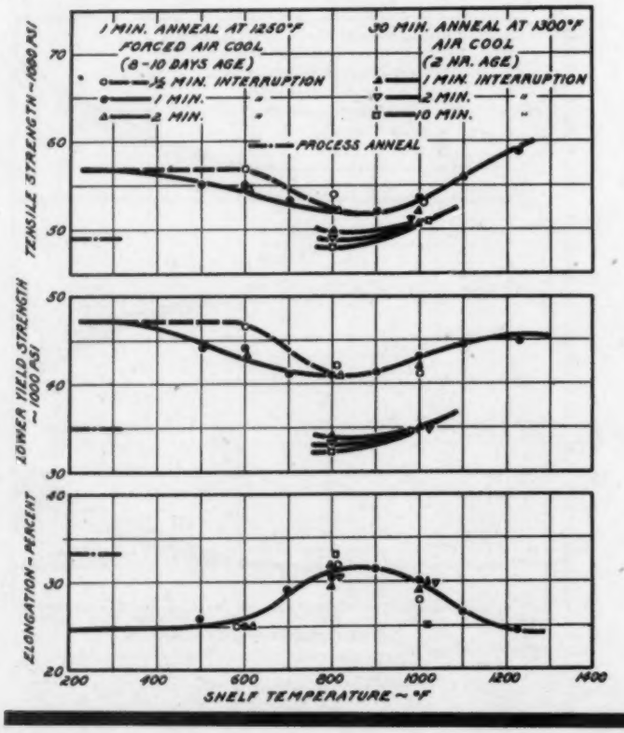
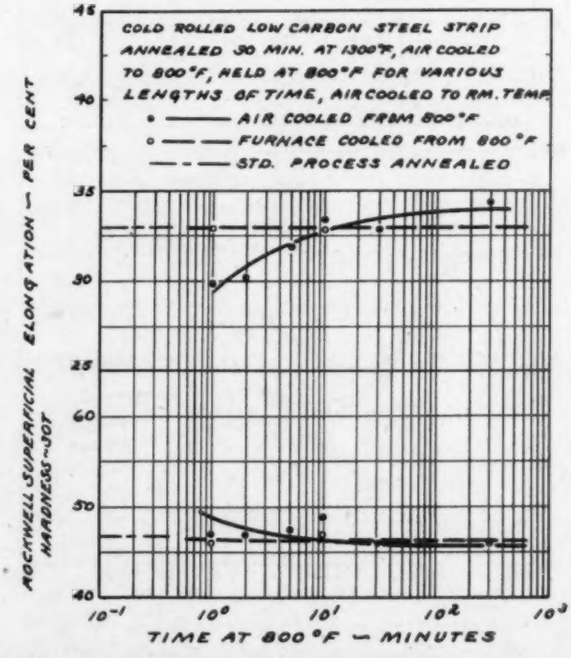

1 MIN. ANNEAL AT 1250°F FORCED AIR COOL (8-10 DAYS AGE)
½ MIN. INTERRUPTION
1 MIN.
2 MIN.
30 MIN. ANNEAL AT 1300°F AIR COOL (2 HR. AGE)
1 MIN. INTERRUPTION
2 MIN.
10 MIN.
PROCESS ANNEAL
TENSILE STRENGTH ~ 1000 PSI
LOWER YIELD STRENGTH ~ 1000 PSI
ELONGATION ~ PERCENT
SHELF TEMPERATURE ~ °F

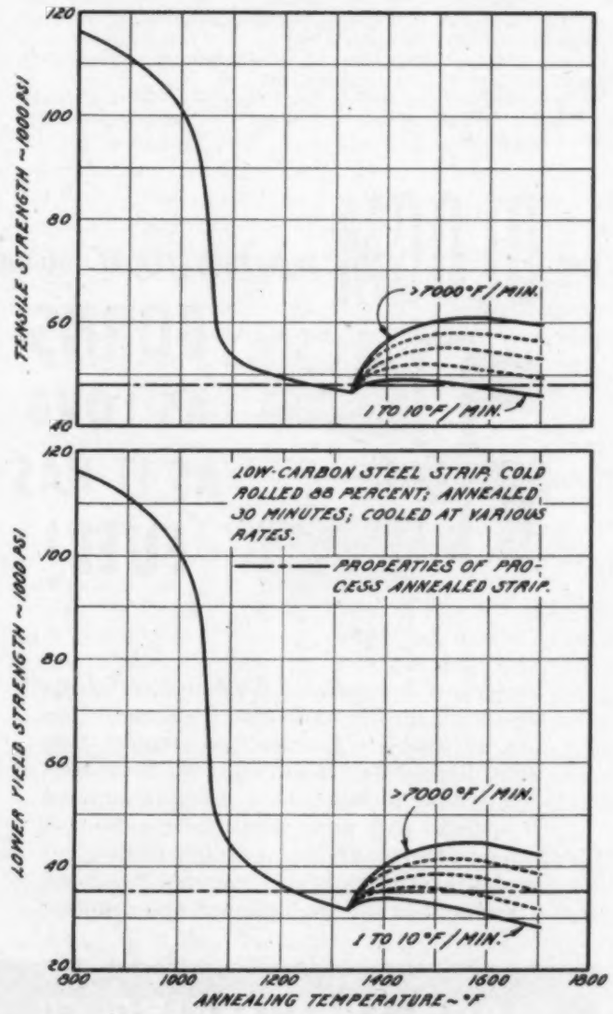
Figure 24 — Effect of holding time at 800 F on some properties of cold rolled, rimmed, low carbon steel strip, annealed 30 minutes at 1300 F.


COLD ROLLED LOW CARBON STEEL STRIP ANNEALED 30 MIN. AT 1300°F, AIR COOLED TO 800°F, HELD AT 800°F FOR VARIOUS LENGTHS OF TIME, AIR COOLED TO RM. TEMP.
AIR COOLED FROM 800°F
FURNACE COOLED FROM 800°F
STD. PROCESS ANNEALED
ROCKWELL SUPERFICIAL HARDNESS ~ 30T
ELONGATION ~ PER CENT
TIME AT 800°F ~ MINUTES

interjection of a very slow cooling rate between two (close) temperatures into the normal cooling rate (sloping shelf). The temperature should be sufficiently high to eliminate that portion of the supersaturated solid solution that might be formed on rapid cooling to that temperature, and low enough to result in a very low degree of supersaturation on subsequent cooling. The optimum shelf temperature was determined to be 800 F, which is in close agreement with the previously determined temperature of 850 F (7). See Figure 22. This has been derived from tests consisting of annealing cold rolled low carbon steel at about 1300 F, rapidly cooling to various (horizontal) shelf temperatures, holding for various times, and finally cooling rapidly to room temperature. The minimum time at 800 F necessary to eliminate the hardening effects was found to be roughly 10 minutes as shown in Figures 23 and 24.

The third hardening effect, the hardenability, is encountered only on annealing at temperatures above 1330 F when, on cooling, the steel necessarily passes through the gamma-alpha transformation temperature

Figure 25 — Effect of various cooling rates on tensile strength and lower yield point.



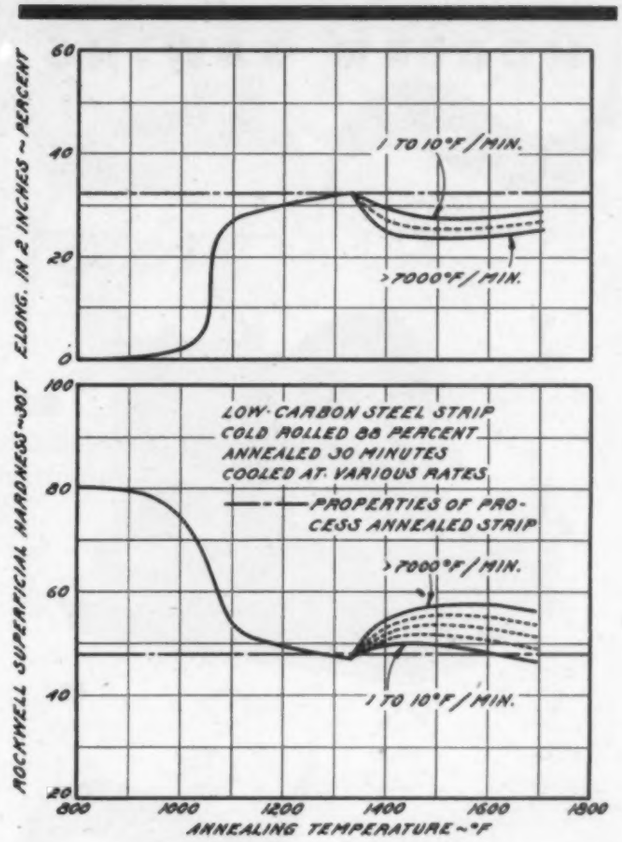
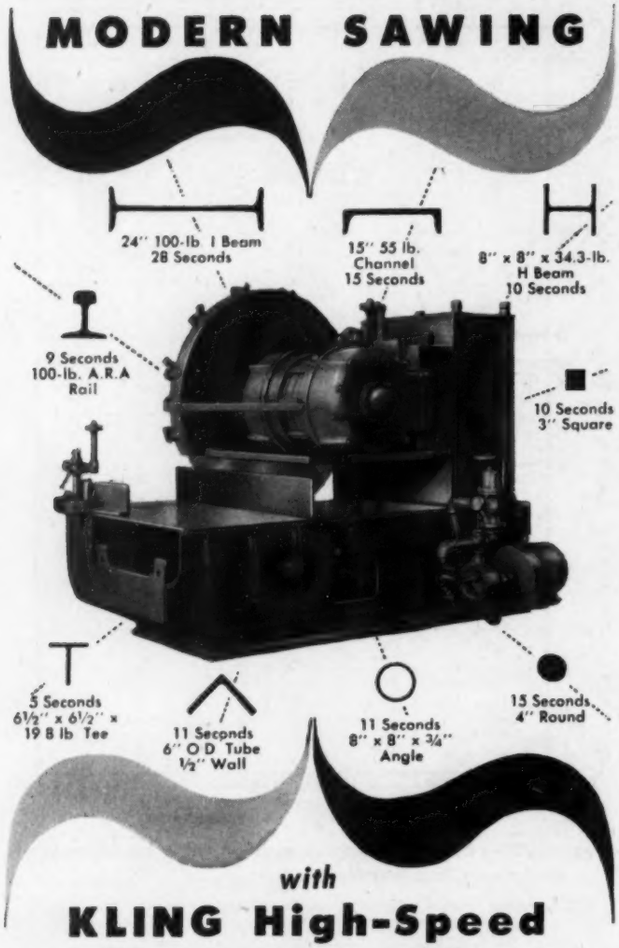


Figure 26 — Effect of various cooling rates on elongation and superficial hardness.

range. Again, this hardening effect (and any other) will be eliminated, or at least held to a minimum, if sufficient time is allowed for the transformation to produce equilibrium conditions progressively. The rate of cool necessary to eliminate hardenability completely was not determined, since even the slowest rate of cool employed in the investigation (furnace cooling) resulted in a small amount of hardenability, see Figures 7 and 8. However, for all practical purposes this rate of cool (1 to 10 F per minute) can be considered sufficient to remove all hardenability.

If, in any commercial annealing cycle, the anneal is considered to be adequate when properties comparable to those of standard process annealed steel are obtained, it becomes unnecessary to remove all hardenability in cooling from annealing temperatures above the lower critical temperature. This is true, since annealing at these higher temperatures produces a greater degree of softening shown in Figure 10. Consequently, a certain degree of hardening may be tolerated to secure properties which are still the same as those of standard process annealed steel. In other words, the cooling rate may be considerably faster than that necessary to completely eliminate all hardenability. This is shown schematically in Figures 25 and 26, in which the degree of hardenability is given for several annealing temperatures and cooling rates, along with the properties of standard process annealed steel. In these figures, the basic properties are those resulting from furnace cooling, while those for the



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fastest rate of cool were obtained from strip, water quenched from the annealing temperature, reheated to 1000 F for 60 minutes and furnace cooled. Intermediate cooling rates are interpolated. The intersection of the trend curve for a given cooling rate with the base line (representing process annealed properties) shows the annealing temperature which should be used, so that if the strip is cooled at that rate, the resultant hardenability is equal to the additional softening gained from the use of a higher annealing temperature. It should be kept in mind that the cooling rates represented in Figures 25 and 26 are those for cooling only to 1330 F, the cooling rate from 1330 F to room temperature being subject to the factors considered previously in the discussion of the elimination of the solid solution and aging effects.

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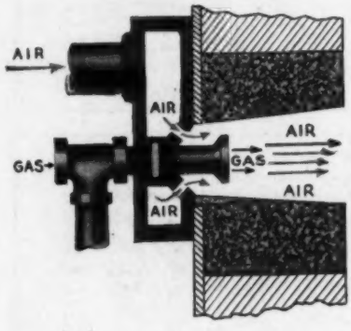

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▲ THE electric motor's valuable and peculiar characteristic of attempting to do a job to the point of self-destruction necessitates its being completely safeguarded. The problem of proper protection is twofold:

Overtorque — Sudden, violent loading which tends to twist off shafts, shear drive gears or keys or strip motor windings. Adequate protection should give consideration to full utilization of motor and drive capacity.

Overload — Moderate prolonged overloads which result mainly in deterioration of motor insulation over a period of time. The motor should be protected from conditions of mechanical load imposed which result in a continuous current above full load current but within stalling ability of the motor.

Overtorque is relatively easy to guard against; a magnetic overload relay will cut off the motor at a predetermined current or torque. This cut-off torque is set at a point having a suitable margin of safety below the destructive torque of the weakest part of the drive mechanism.

Damage due to overload is more difficult to prevent. Mill motors today usually are rugged, wisely selected for their job, and stand a lot of punishment. Production departments want to get the most out of them. Maintenance departments like to figure the life expectancy of their drives in order to replace the motor at the most opportune time. Far less objection would be raised over replacing a motor a month too soon than a minute too late.

The problem then is to protect the motor so that it reaches its life expectancy without interfering greatly with its continuity of service. A theoretically correct overload relay limits operation to that which will permit the motor to outlive its expectancy. Such an ideal device would probably be impractical even if it could be designed and built. The most that can be hoped for is a device which will automatically cut the motor off whenever it is given an amount of overloading which would materially shorten its life expectancy. This device should, of course, also include a feature which protects the motor from excessive torque.

OVERLOAD DEVICES

Many such approaches to this problem have been made in the past. The earliest was the simple fuse. A prolonged, moderate overload blew the fuse in time, yet a short circuit blew it practically at once. The fuse was not a satisfactory answer for overload protection. It lacked the necessary degree of inverse time delay characteristic to permit starting the heavy loads, and the necessity for replacing blown fuse links offered the possibility that nails might be substituted, thereby destroying protection normally afforded. Then came the magnetic overload relay, which consisted of a plunger which lifted at a definite current value thus opening the line switch. Action was instantaneous. Delaying action was later added to the plunger in one of several forms, an oil or air dashpot, as well as other means, which restrained the motion of the plunger, allowing it to move slowly on a light overload, and faster on a heavier load. Then the overload relay performed as a time delay device, the instantaneous feature having been destroyed.

The characteristic operation of time delay with a solenoid and plunger is such that the relay has an inherent defect of creeping. Let us assume that the plunger is set to complete its stroke in two minutes on a 200 per cent load. A load of this magnitude for only one minute would cause the plunger to rise for part of its stroke. Although the overload condition would be of short duration, the plunger would remain in its raised position on normal load conditions. This is due to an

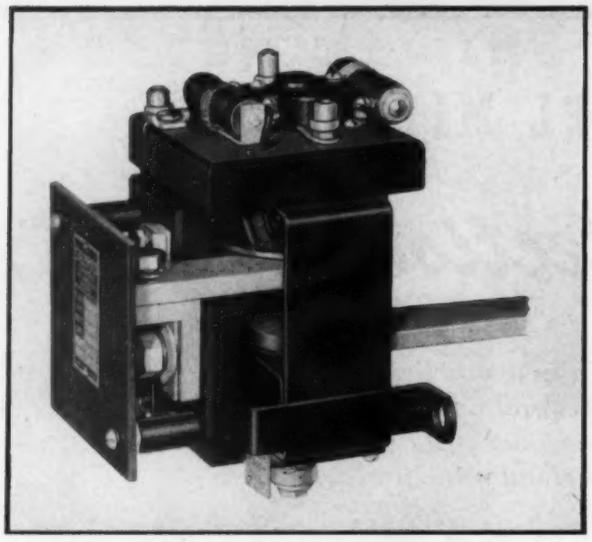


Figure 1 — This overload relay combines thermal and instantaneous protection in one unit.

increase of magnetic pull with a decrease in air gap. At some later time, when the 200 per cent load was again encountered, the plunger would have to raise through only part of its normal stroke. The tripping time would then be for less than the two minutes originally based on a 200 per cent load.

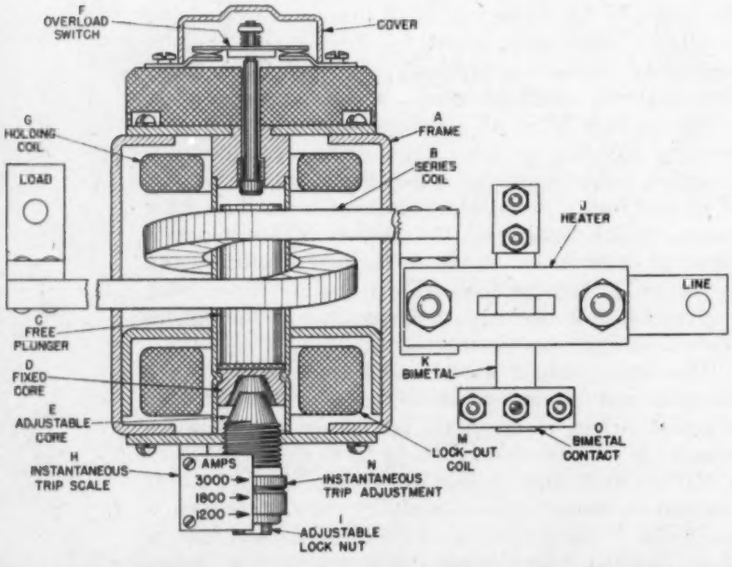
Later thermal delays were developed, solder pot, bi-metal and other types. These relays offer the required inverse time characteristic and reset features without the disadvantage of creeping. They have no instantaneous feature.

The characteristics of thermal overload relays are a fair approach to some of the requirements of a satisfactory protective device. A motor that reaches its temperature limit in 30 minutes on 130 per cent load will reach the same limit in about 15 minutes on 180 per cent load. The thermal overload relay will do roughly the same thing. Basically, the thermal relay design involves a device having a thermal capacity which resembles the heat-temperature characteristic of motor and thereby duplicates a proportionate value of the actual motor temperature.

It would seem then, that, in general, the best solution to the problem of protection would be to use two overload relays:

1. A thermal overload relay to trip on moderate overloads which will not damage the motor unless continued for a length of time.
2. An instantaneous magnetic overload relay to trip on sudden high surges of power which the motor should not be called upon to endure at any time.

Figure 2 — Sectional view of relay showing operation of component parts.



NEW OVERLOAD RELAY

An overload relay which combines these two types of operation in one structure is depicted in Figure 1. Figure 2 shows its scheme of operation, and Figure 3 shows its electrical connections. In Figure 2, the overload relay comprises a plunger (C) surrounded by 3 coils, series coil (B), lockout coil (M) and holding coil (G). The load current passing through the series coil tends to lift the plunger (C), but the lockout coil (M) tends to hold the plunger down.

The load current also passes through a heating element (J) adjacent to a bi-metal switch (K). A sustained overload heats bi-metal (K). Deflection of the bi-metal opens contact (O), which is in the circuit of the lockout coil. De-energizing the lockout coil relieves the downward pull on the plunger (C) and allows it to lift under the pull of the series coil. Upward motion of the plunger opens relay contacts (F), dropping out the line contactor (L). Thus, the time required for tripping depends on both the magnitude of the load current and its time of duration, the greater the load, the less the time, and vice versa.

If, however, an unusually heavy current flows in the series coil, its pull will overcome the restraint of the lockout coil and the plunger (C) will lift, without waiting for the bi-metal blade to open the lockout coil circuit. Thus, the overload relay described will trip under either of two conditions:

1. After inverse time delay under a maintained moderate overload, or
2. Instantaneously under an excessive overload.

The restraining force on the plunger, due to the lockout coil, a shunt coil across the line, is varied by adjusting the air gap between the fixed core (D) and the movable core (E). Decreasing this air gap, increases the magnetic restraint on the plunger and increases the value of the load current necessary to lift the plunger away from the lockout coil. Scale (H) shows the setting of the adjustable core in terms of amperes line current

necessary for instantaneous tripping. A nut (I) locks the adjustment in place.

Above the series coil (B) is the shunt holding coil (G). Connected across the line, it holds plunger (C) in raised position, keeping contact (F) open. The relay must then be "remote reset" by opening the holding coil circuit using some conveniently located switch or push button which could be locked to require operation by a member of the electrical department or some other authorized individual. For "automatic reset," the holding coil is de-energized when the relay trips, causing the relay to immediately reset itself. The schematic diagram, Figure 3, is a convenient means of indicating these features. A master switch in conjunction with an undervoltage relay can be arranged to provide the equivalent of the "automatic reset" operation illustrated in Figure 3. With overload tripped, the master switch must be returned to the "off" position to energize the UV relay, the circuit of which is maintained through the overload contacts that are automatically reset. The master switch can then be positioned for normal operation.

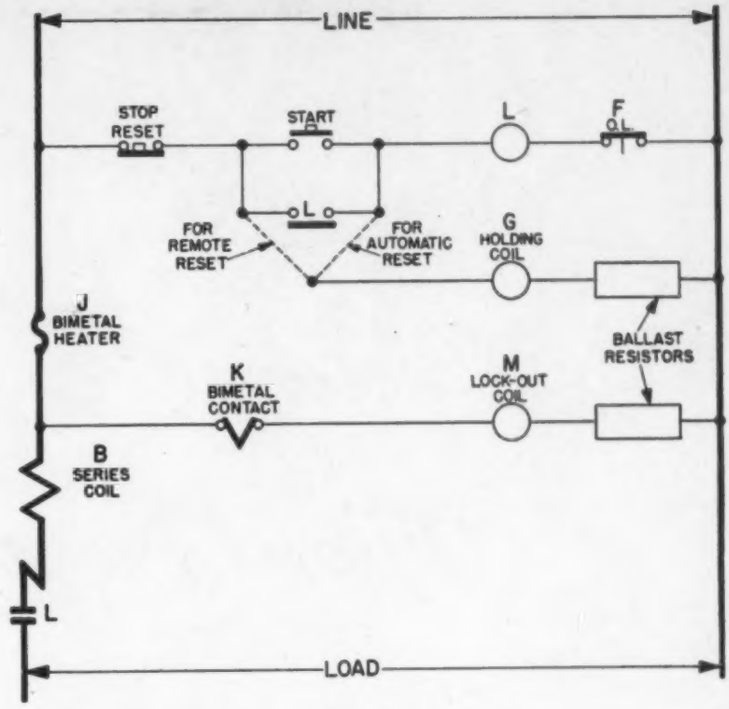


Figure 3 — Electrical connection diagram for steel mill overload relay.

COIL AND HEATER SELECTION

One overload relay structure with only slight modifications covers a range of 50 to 600 amperes. Two elements are selected for each actual application:

1. The series coil which determines the overtorque protection obtained, and

2. The heating element which determines the overcurrent protection.

Series coil for overtorque — Since the starting torque capacity of the usual compound wound mill motor is about four times the 60 minute rating, the series coil should be selected with a range of adjustment that includes the value of current which corresponds to four times the 60 minute torque rating of the motor. For example, a 25 hp, 230 volt motor with a 60 minute 100 per cent torque rating of 97 amperes might develop 400 per cent torque at 410 amperes.

Thus, a "100 ampere" coil with calibration scale of from 200 to 500 amperes is the correct selection. The rating of the coil corresponds with the 60 minute, 100 per cent current rating of the motor and the instantaneous trip range includes the 410 amperes expected at the 400 per cent torque limit.

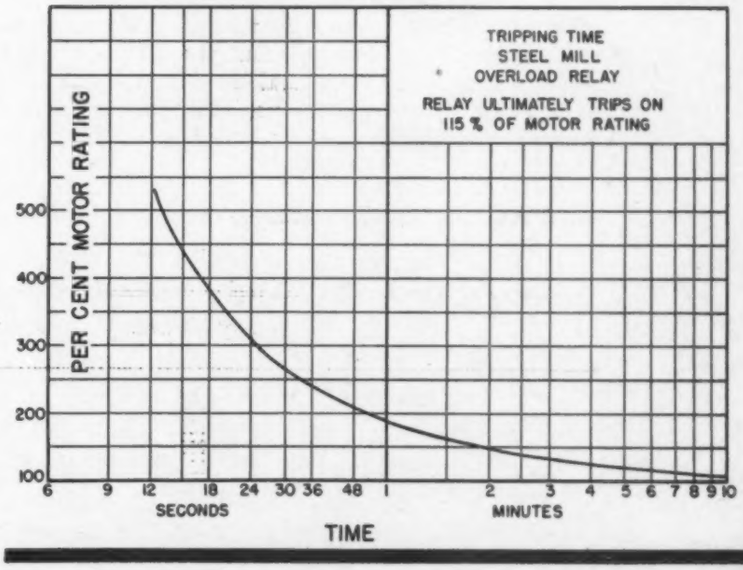
Heating element for overload — The selection of the heater element should be such to permit the motor to handle 100 per cent load for at least an hour. Since a heater element's designated rating is that current which will ultimately trip the relay, a heater should be selected having a rating from 110 to 115 per cent of the motor's 60 minute rating. Figure 4 shows the approximate tripping time of a relay having a heater element whose rating is 115 per cent of the motor's full load rating.

A mill motor of this size should safely commutate 300 per cent current for the 24 second period required to trip the overload relay at that current value.

CONCLUSIONS

Proper overtorque and overload protection permits maximum utilization of a motor without shortening its life expectancy. Both instantaneous overtorque and inverse time overload features are required. Combination of the two features in a single unit, one unit of which may be connected in each side of the power supply to the motor armature, affords maximum protection.

Figure 4 — This curve shows range of trip time of steel mill overload relay at various per cent loads at 30 C ambient with bimetal tripping at 100 C.



HOW TO USE

Welding Equipment to Thaw Frozen Water Pipes

by R. F. Wyer

ELECTRICAL WELDING DIVISION

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

▲ THE use of electric welding equipment to thaw frozen water pipes has been practiced successfully by a number of plant owners during the past few winters. Welding equipment offers advantages over other electrical means because it is self-regulating and can be accurately controlled. In addition, it is being put to good use in a season when it might otherwise remain idle.

No special equipment is necessary for doing this work other than reliable pipe clamps for making firm electrical connections. Strap-type clamps of copper, having ample section to carry several hundred amperes, are desirable. C-clamps may be used to clamp cable terminals directly to the pipe where necessary. A file, rasp, or abrasive cloth may be used to remove zinc oxide, rust, paint, and grease to assure a good electrical contact.

Cable should never be wrapped around the pipe as a connection, since it is practically certain to loosen, and may cause hazardous sparking. Ordinary pipe wrenches are required for disconnecting piping. A portable voltmeter is useful for checking voltage drops and determining the continuity of circuits.

The connections to the welding generator are made in the ordinary way with the work lead and electrode lead both connected to the pipe on opposite ends of the frozen section so that the heat generated in the pipe wall by the passage of current will thaw the ice in the

TABLE I

Pipe diameter, in.	Recommended amperes	Approximate minutes to thaw	Recommended cable size	Resistance per 100 ft of cable
¼	75	15	No. 6	0.0395
½	125	20	No. 2	0.0156
¾	200	20	No. 0	0.00984
1	250	30	No. 00	0.00780
1½	300	30	No. 000	0.00619
2	350	40	No. 0000	0.00491
4	600	75	400,000 cm	0.00270
6	800	120	600,000 cm	0.00180

TABLE II

Ohm Resistance per 100 Feet

Standard Pipes

Pipe diameter, in.	Wrought iron	Steel	Copper tubing	Lead	Cast iron, class A
½	0.026	0.0198	0.00824	0.0234	.....
¾	0.0202	0.01485	0.00445	0.01371	.....
1	0.0138	0.0100	0.0034	0.00384	.....
1½	0.00842	0.00618	0.00208	0.0064	.....
2	0.00625	0.0046	0.00133	0.0053	.....
4	.....	.....	.....	.....	0.0092
6	.....	.....	.....	.....	0.006

pipe. The method of getting at the pipe will vary in almost every case, but for economy, it is desirable to get as close to the frozen portion as is feasible without excessive digging in frozen ground. It is desirable to set the machine at the lowest current output adjustment at the beginning of a thawing interval in order to permit checking connections with the least likelihood of flashing.

While the proper current for thawing pipes has been established as between 200 and 500 amperes, the time needed to complete the job varies greatly according to the size, length, kind, and location of the pipe, condition of the surrounding soil, extent of the freeze, and temperature of the air. Tables I and II will help determine the various factors involved.

While the resistances given are for direct current, the reactance is so small that it can ordinarily be neglected when cables are not coiled. There are so many other variables in a given case, that the voltage necessary to produce the current will be, for all practical purposes, the same for both a-c and d-c. Table III shows the maximum outputs which can be obtained from the arc welding equipment which would normally be used for pipe-thawing purposes.

Where welding sets are to be operated at less than 80 per cent of their ampere rating, the operation can be continuous. That is, a 400-ampere d-c set can be operated continuously at 320 amperes without damage. Likewise, a 500-ampere transformer can be operated at 400 amperes continuous. The sets may be operated at their maximum output for intermittent periods up to 15 minutes if sufficient time is allowed for return to normal temperature.

When using arc welding equipment for thawing purposes, there are a number of precautions which must be observed. If a good, low-resistance joint is not obtained between the copper cable and water pipe, excessive heat will be generated at the connection. If the current is allowed to form an arc at this point, it may damage the pipe.

Care should be taken to select the correct amount of current where there is known to be lead in the service pipe, because lead pipes will stand less current than iron. The pipes should be disconnected from the building piping before the wiring so that the current has only one path in which to travel, through the section which is frozen. If this is not done, where other devices are grounded to the water pipes, the ground wires may burn out and cause a fire, since the grounding connections will be raised above earth potential.

In using single-operator d-c sets, two points should be noted. The low load voltage will result in the possibility of unusually heavy current on the lower taps. Since these taps are designed to carry the low currents which will be drawn at normal operating voltages, the result may be to overheat portions of the series field. This can be avoided by setting the units on the highest tap and lowest open-circuit voltage which will give the desired current.

In addition, the low load voltage should be considered in making an estimate of the current setting required. Since load voltages in the neighborhood of 5 or 6 volts will often be encountered, the output current on any setting will be as much as 1½ times the current which would be drawn by a welding arc. With transformers, however, the current drawn by the load will be very nearly that indicated on the nameplate.

As a final precaution, the resistance of the joints in the pipe should be determined. If the joints are insulated by rust or pipe dope, a spark may start a fire.

TABLE III

Equipment	10 volts	20 volts	30 volts	40 volts
300-amp a-c welders	500 amp	450 amp	400 amp	375 amp
500-amp a-c welders	800 amp	750 amp	700 amp	625 amp
300 amp d-c welders	650 amp	600 amp	500 amp	400 amp
400 amp d-c welders	800 amp	750 amp	700 amp	600 amp
600 amp d-c welders	1200 amp	1000 amp	900 amp	700 amp

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Installment-plan buying won't give you the most for your money in wire and cable. A low price per foot may look attractive, but if you have to repeat the purchase again and again because it failed to stand up under severe operating conditions you are pyramiding the cost and piling a lot of installation expense on top of it. Add service interruptions, lost production and shutdown possibilities to that and you have something worth thinking about.

If you want to keep your circuits functioning on an economical basis check up on how long they are lasting around boilers, furnaces, kilns, soaking pits, and in power plants, steam tunnels, pump rooms or other hot-spots. Find out how often they have to be replaced and plan to re-wire the maintenance-boosters with *permanently insulated* Rockbestos A.V.C. wires, cables, cords that are designed to operate *continuously* at 230°F., without baking brittle, cracking or flowing.

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NEWS SUPPLEMENT November, 1946

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NEW STEEL SURFACE PYROMETER ASSURES MORE UNIFORM STEEL PRODUCT

▲ More uniform products of steel from the slab to the finishing processes are assured by the use of a new steel surface pyrometer recently designed and patented by scientists of the Research Laboratory, United States Steel Corporation of Delaware at Kearny, New Jersey. This radiation type of heat recorder takes the external temperature of nearly white-hot slabs of steel as they pass in review in the heating furnace, preparatory to entrance into rolling mills which may convert them to a variety of products ranging from ship plates and automobile and railroad car sheets to galvanized roofing and tin-plated material for cans.

In addition to making certain that slabs reach the prescribed temperatures in their progress to forming and fabricating operations, the new pyrometer aids research in the design of effective furnaces, locating heat leaks and other points of inefficiency. The long-handled, malletlike instrument, which may be operated by one man, is designed to perform successfully up to a slab surface temperature of 2400 F.

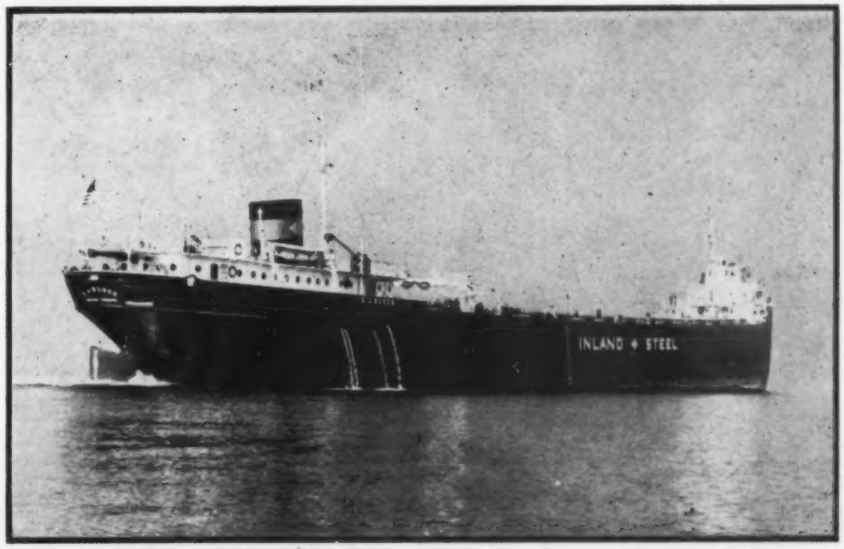
As explained by the inventors of this instrument, pyrometers are used in steel mills to measure and record temperatures above red heat, that is, upwards of 1000 F, in coke ovens and blast furnaces, at key positions inside open hearth melting furnaces, in molten steel baths, inside steel slabs, in the forming and fabricating mills and elsewhere. Below this range, they assert, steel temperatures fall more or less into the category of thermometry.

Working at temperatures that are low by steel mill standards, the housewife takes an inexact temperature reading of her "hot" iron by touching its heated surface with a wet finger and listening for the sizzle. The difference between a household ironing temperature, perhaps 400 F at the most, and that of pinkish incandescent slabs of really hot steel which are ready for rolling may be easily judged by the difference in materials and size between Mrs. America's dainty finger and the 50-pound steel surface pyrometer, made of heat-resistant materials and protected with refractories.

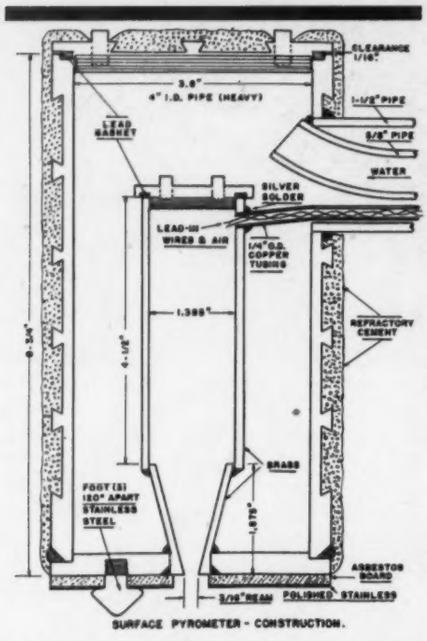
The surface temperature of a furnace-hot steel slab is so great it must be measured by the radiation reaching a specially designed radiation tube through a lens lodged inside the pyrometer's cylindrical head, the reading being transmitted by wires through the long handle to a recording potentiometer. The head itself, 8¾ in. high by about 4 in. in diameter, is water cooled inside its steel and brass jacket. Except for the orifice containing the lens, the working surface is of polished stainless steel backed by asbestos and stands upon three squat stainless steel legs.

By means of its handle, this pyrometer is thrust through a door into the furnace to come to rest on its feet above the area whose temperature is sought. It is desirable that readings be taken quickly. This can be done, say the inventors, in 3 to 5 seconds

DIESEL-ELECTRIC POWER FOR LAKE SHIP



The "E. J. Block," owned by the Inland Steel Company and recently converted from steam to diesel-electric made its first test run on Lake Erie recently. The main engines consist of two General Motors two-cycle, v-type, diesel engines of 1200 bhp each at 750 rpm. Each engine, having a bore of 8¾ in. and a stroke of 10½ in., has a piston speed of 1313 ft per min when operating at its rated speed, with full power available through electric drive on the propeller over a shaft speed range of 73 to 86 rpm. The 38-year-old ship has been completely rebuilt from stem to stern. ——11-E-1——



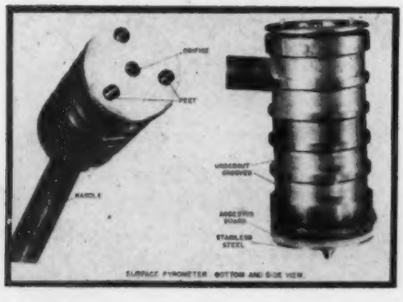
The head itself, 8¾ in. high by about 4 in. in diameter, is water cooled inside its steel and brass jacket.

when used with a high-speed recording potentiometer, but may require up to 25 seconds, as well as an experienced handler, if only a manually operated potentiometer is available.

Complete assembly of the radiation unit within the head was calibrated in the laboratory by using as a target a heated plate, whose temperature was measured by a platinum platinum-rhodium thermocouple with its hot junction solidly hammered into a small, shallow hole drilled in the center of the target circle. It is believed by the inventors that the accuracy of the assembled unit is about plus or minus 5 degrees as long as the surrounding temperature of the radiation tube is kept within the range of 80 to 110 F.

The new instrument has been patented by J. W. Percy, of the Research Laboratory staff; John Johnston, director, and R. B. Sosman, assistant director of the Laboratory, the patent having been assigned to United States Steel Corporation. These men have found that by correlating the surface temperature of steel slabs with the internal temperature obtained by another pyrometer designed in 1940, furnace temperatures and radiation — or heating efficiency — may be properly interpreted. The present model was designed for use primarily in reheating furnaces. Tests have proved it simple in operation and reliable in its indications.

The temperature is measured by the radiation reaching a specially-designed radiation tube through a lens in the cylindrical head.



AGMA RECOMMENDS GEARS FOR AISE SPECIFICATIONS

▲ The 1946 semi-annual meeting of the American Gear Manufacturers Association which was held at Edgewater Beach, Chicago, Illinois, on October 27, 28, 29 and 30, was of particular interest to the members of the Association of Iron and Steel Engineers. The AGMA, in addition to their regular program, completed extensive committee work in the preparation of a set of proposed gear specifications which the AGMA recommends should be used in the AISE Specifications for Electric Overhead Traveling Cranes. The work goes back several years to a time when the AISE requested criticism on their existing gear specification.

The new specifications embody the latest design and engineering information now available on gearing. They were made possible by a new AGMA standard on "Surface Durability of Spur Gears," and another standard, "Rating for Strength of Spur Gear Teeth," which were just approved by the AGMA, and which will be published shortly by them. New specifications cover primarily 20 degree stub, 20 degree full depth, and 14½ degree full depth teeth. The recommendation and trend of the gear manufacturers is to the 20 degree full depth form. Specifications have been arranged for easy application in calculations. A formula is given for surface durability and another formula is given for strength. The various factors which go in the formula are picked out of tables which have been worked out by the AGMA committee. By selecting the appropriate factors, inserting them in the formulae, multiplying, and then selecting the governing value (in some cases this would be wear, in other cases strength) the answer is obtained. The specification is so designed that it can be applied to any type of material, the factor being determined by the ratio of the Brinell hardness number of the pinion to the gear.

The committee primarily responsible for this work is the open gearing committee under the chairmanship of Clarence R. Burrell, general sales manager, The Tool Steel Gear and Pinion Company, which committee is a sub-committee of the general commercial committee headed by F. N. Walker, vice president, Philadelphia Gear Works, Inc. The detailed engineering data was prepared by F. Richardz, chairman of the spur gearing committee and manager, gearing engineering department, Nuttall works, Westinghouse Electric Corporation. The spur gearing committee is a sub-committee of the AGMA engineering committee headed by Charles R. Staub, chief engineer, Michigan Tool Company.

The first two days and the last day of the AGMA meeting were devoted entirely to meetings of the various committees. The technical papers were given on the third day. These included a most interesting paper entitled "Evaluating Surface Roughness of Gear Teeth," by L. D. Martin, Eastman Kodak Company, and L. J. Collins, General Electric Company. This paper was a report on a research

TRANSFORMER FIRM MOVES TO NEWLY ACQUIRED PLANT

Pennsylvania Transformer Company of Pittsburgh, Pennsylvania, announced that they have acquired from War Assets Administration, buildings No. 20 and 25 of the Aluminum Forging Plant in Canonsburg, Pennsylvania. Large transformers will be completely manufactured and assembled in the larger of the two Canonsburg buildings. Offices for many of the company's departments will be housed in part of the second building, where smaller transformers will be manufactured and assembled.

The Mill Operator Who Learned to Control His Temper.

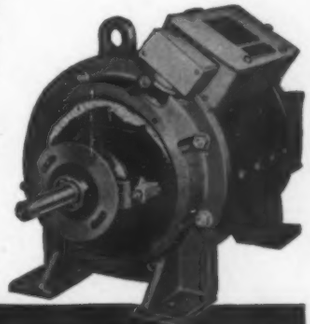
FEW THINGS ARE HARDER on the temper of a steel mill operator than time lost due to a "cobble" while rolling steel. And similarly, nothing is so hard on the temper of *steel* as rolling under *uneven tension.*

A wise operator learned to control both his own temper and that of his steel by installing accurate "Regulex" control on his temper mill. Through close control of strip tension during all the stages of reel build-up, from stand-still . . . to top speed . . . to deceleration, "Regulex" control helped him produce tempered steel of superior quality, as well as a compact, evenly-wound coil.

Moreover, the operator found that when he replaced old-type equipment with high speed "Regulex" control, he actually *doubled* the daily capacity of his mill!

MORAL: Modern "Regulex" control has wide application in steel plants . . . wherever rapid adjustments are needed in torque, tension, speed, current, or any other variable which can be measured electrically. By its fast response, without overshooting, it helps increase production, save money, protect machines. "Regulex" control systems involve fewer contactors, no trick circuits . . . machines themselves are simple and rugged.

For the full story on "Regulex" control, see our nearby sales office, or write ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN. A 2078



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You save the trouble and expense of bolting or welding counterbalance connections to your Swivel Joints when you use CHIKSAN *Ball-Bearing* Swivel Joints . . . because CHIKSAN Joints are provided with counterbalance connections as an integral part of the Swivel Joint. Lines are quickly and easily fitted up merely by threading in pipe of required length and attaching counterbalance weight, thus making the line lighter and easier to handle. Many other applications are in use. Write for latest Chiksan Catalog. Over 500 different Types, Styles and Sizes for every purpose.

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project which involved various methods of grading gear teeth surfaces. Much work remains to be done on this project. The other paper was entitled "Jet Propulsion and Gas Turbines in Aviation," and was presented by H. J. Clyman, Westinghouse Electric Corporation. Basic factors in the development of future aviation engines were discussed in this paper, and Mr Clyman is of the opinion that for commercial airplanes, the gas turbine propeller type of power plant is the coming thing, whereas the rocket type engine will find its application in military craft. He indicated in his talk that future developments in such engines will require gearing which must run under conditions and speeds far above those now normally used.

GENEVA, UTAH NOW BASING POINT FOR GENEVA STEEL

▲ Geneva Steel Company announces that, effective October 14, 1946, it established Geneva, Utah as a basing point applying to its sales of sheared steel plates, within the range of sizes,

WORLD'S LARGEST TRUCK SOON TO HAVE SUCCESSOR

The largest fork truck ever built is this 15-ton capacity Automatic truck shown handling sheet steel in a rolling mill. Designed by B. I. Ulinski at Automatic Transportation Company in 1939 when steel mills requested such a truck to keep pace with advancing manufacturing processes, this truck is still the largest in the world. It is used by several of America's largest steel mills, both with forks as shown and with interchangeable ram for handling sheet steel coils. Even this giant, however, will be dwarfed by the trucks which Ulinksi is now planning for postwar industry. He is now working on drawings for a fork truck with twice the load capacity of one shown below — a 30-ton capacity unit, which will be produced whenever steel milling processes are further developed sufficiently to demand such a truck.

—11-E-2—

"3C" Bulletin 106 D. C. SHOE TYPE BRAKES *available in 10", 14", 18", 21" and 26" Sizes—Series or Shunt Wound*

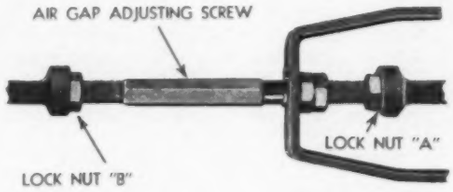
Thousands of these Brakes gave exceptional service in heavy duty Maritime service during World War II. They are now available for industrial use in the sizes shown above. Simplicity of installation and maintenance adjustments, plus long life and minimum wear in heavy duty applications are features. All adjustments are plainly visible—no feeler gauges or other devices required to secure accurate adjustments.

INSTALLATION ADJUSTMENTS

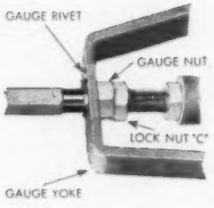
When the center line of the wheel mounted on the motor shaft does not coincide with that of the brake, the following simple adjustments are made with the magnet de-energized.

AIR GAP

Loosen lock nuts A and B, turn adjusting screw until air gap, measured between bottom of armature and magnet face, is 3/64" on 14" and larger brakes, or 1/16" on 10" size. Tighten lock nuts after adjustment is made.

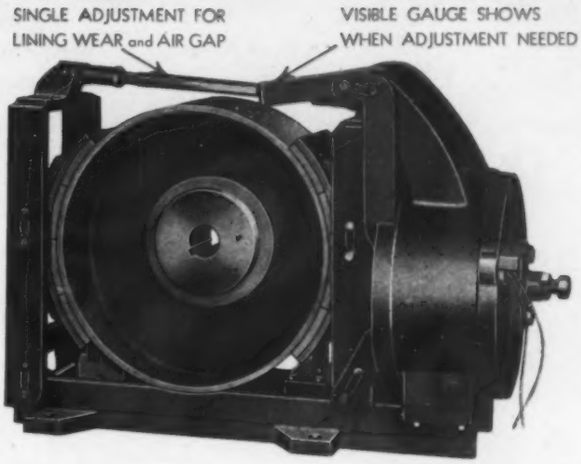


SHOE CLEARANCE

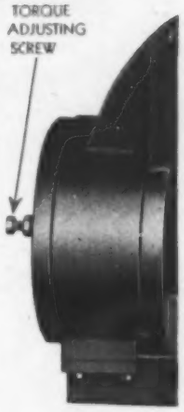


Loosen Lock Nut C, turn gauge nut until face of gauge nut sleeve is flush with face of gauge rivet. Tighten lock nut.

Our nearest District Office or Agency will gladly give you full details. Ask for Description Bulletin 106.



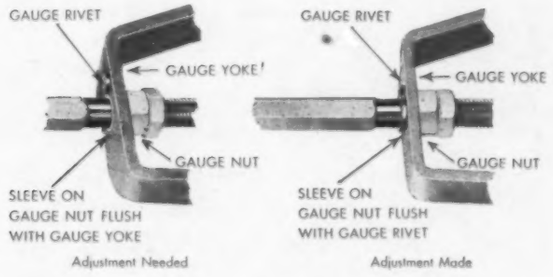
TORQUE



At shipment, the brake is set for full torque rating of the installed coil. This is usually equal to, or greater than the full load torque of the motor. To adjust, after installation, turn screw at rear center of magnet "IN" to increase or "OUT" to decrease torque setting of brake.

MAINTENANCE ADJUSTMENT

Lining wear is the only maintenance adjustment. Necessary adjustment can be checked at a glance. See pictures below.



To adjust, loosen lock nuts A and B (see picture under "AIR GAP"). Turn adjusting screw until gauge nut sleeve is again flush with the gauge rivet. This one simple adjustment automatically adjusts for magnet air gap and shoe clearance. *That's simplicity that counts!*

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Prices are subject to the seller's current list of extras, standard conditions of sale, and are subject to change without notice. Shipments will be invoiced at prices and extras in effect at time of shipment, but such prices shall not exceed the applicable maximum prices lawfully established by the Office of Price Administration and in effect at time of shipment.

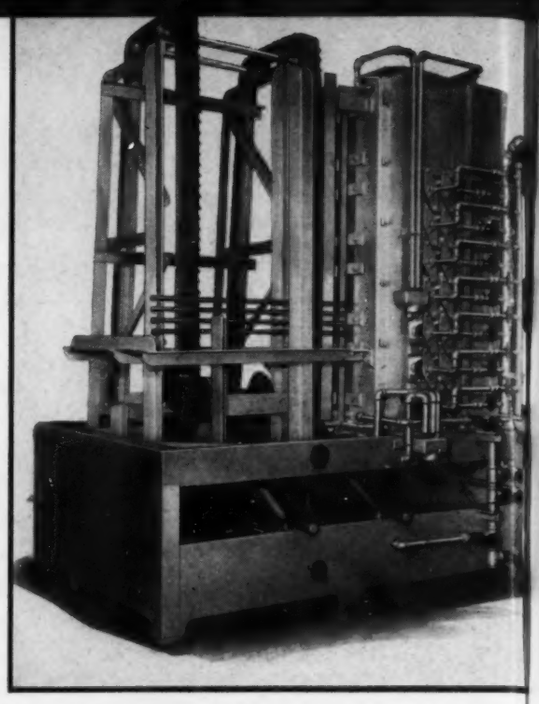
FORGE FURNACES ARE IMPROVING QUALITY

▲ Reports indicate that the users of the Selas vertical bar-end forge furnace are obtaining important quality improvements at lower operating costs. Metallurgical results are uniform due to an exactly reproduceable time-temperature cycle which is of such short duration that there is hardly time for scale to form. As a result, dies which formerly had to be replaced every two or three days now last two or three times as long, The furnace, being vertical, requires but little floor space and is placed to become part of a continuous line operation. No fan need be used to keep the operator cool, and the easily accessible charge and discharge arrangements facilitate bar handling.

The arrangement illustrated is designed for bars sixty-five inches long, flexibility is provided for handling diameters from ½ to 1½ inches. The length of the bar to be heated and the temperature to which it is raised can be closely controlled. In a typical operation which heats 7 inches of a ⅞ inch bar to 2200 F at the rate of 480 per hour, cost of fuel gas and power is but 58 cents per hour.

The bars are placed in a conveyor on one side of the furnace and the ends pass through a short water-cooled heating zone fired by 28 Duradiant burners. The bar ends are heated to forging temperature and the bars are then discharged down two inclined rails on the opposite side of the furnace to the press operator.

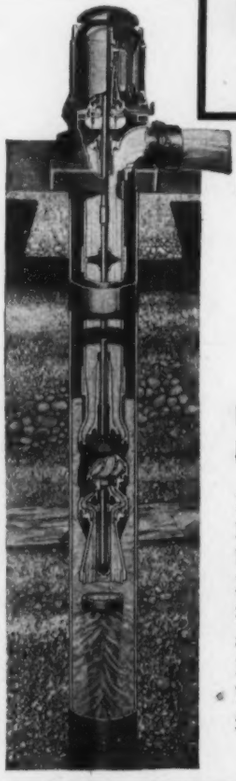
Better metallurgical results are obtained and the initial cost of the



Adapted to production-line techniques, this bar-end forge furnace heats the ends of approximately 500 bars per hour. Uniform heat treatment with minimum scale results in greatly increased forging die life.

PEERLESS PUMPS

Vertical and Horizontal Types



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WORLDS of WATER for INDUSTRIAL USES with PEERLESS VERTICAL TURBINE PUMPS

Developing capacities from 15 to 30,000 g.p.m., against heads up to 1,000 feet, Peerless Vertical Deep Well Turbine Pumps assure a constant and clean water supply. Many exclusive engineering features, such as Double Seal – Double Bearing Bowl Construction, give added assurance of long life and maintenance of efficiencies. Peerless Deep Well Turbine Pumps are available in both oil or water lubricated types (water lubricated illlustrated) and are adaptable to all forms of drive.

Peerless **HORIZONTAL CENTRIFUGAL PUMPS**

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Glass-enclosed mercury Con-Tac-Tor Switches — assure perfect contacts every time — free from the effects of dirt, dust and corrosive atmospheres.

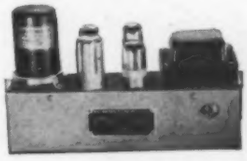
plus

Direct Operation — switches are directly connected to the balancing motor at all times. It is impossible for these units to get out of phase with each other.

plus

Completely enclosed slidewire — sealed against dust and atmospheric conditions — spiral winding permits longer length — 1600 convolutions.

plus



Brown "Continuous Balance" System — eliminates galvanometer — provides greater accuracy, sensitivity, speed of response and thus closer control.

For five years, the Brown ElectroniK Potentiometer has proven superior in every measure of performance. Thousands of users acclaimed it as an Indicator, Recorder and Air-Operated Controller — NOW it is available as an electric controller.

The wide variety of models provides fourteen different switching actions for operation of electric control devices ranging from simple solenoids to complex input controllers. The control point is easily set by a knob on the front of the instrument.

Positive mercury switch control plus the Brown "Continuous Balance" with its inherently greater accuracy and speed of response — offers to electric control users a degree of precision never before possible.

THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Company*, 4464 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities.

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This instrument is completely described in the new Brown Catalog No. 15-9. We will be glad to send you a copy upon request.

BROWN *Electronik* POTENTIOMETERS

equipment which includes Flo-scopes, combustion controller and other accessories can be realized in a relatively short period by reductions in operating costs. Full technical information can be obtained from the Selas Corporation of America.

—11-E-3—

CRANE CAB HEATING UNIT MAINTAINS 75 F AT ZERO

▲ The Lintern ventilating heater maintains a temperature of 75 F at zero outside, in crane cabs up to 500 cu ft. It is streamlined and takes but little space, being only 22 in. high. It is ideal for ventilating and heating those crane cabs which do not require mechanical refrigeration or fume, gas and smoke filters. It circulates the filtered fresh air rapidly, heated in cold weather to a satisfactory temperature.

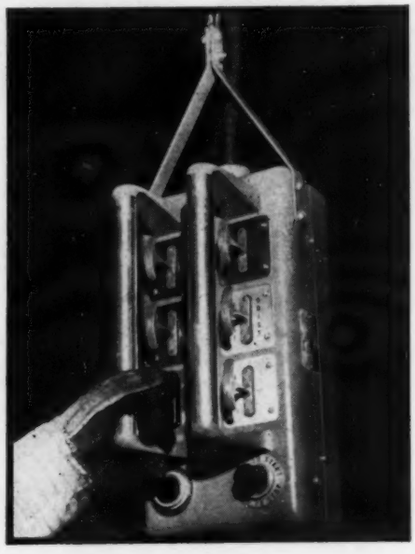
This heater eliminates the possibility of claims resulting from shocks or burns caused by ineffective, dangerous, dormant type heaters. It is a protection to new and inexperienced help against possibility of accidents. It is air insulated — completely concealed operating parts and electrical connections. It has an oversize motor and control for heavy industrial service; air deflection is over an 180 degree range.

The Leater finds wide use not only for crane cabs on all general purpose cranes, but also in cold locations — shanty houses and out-buildings — in and around plants.

—11-E-4—

PENDANT STATIONS FOR FLOOR-OPERATED CRANES

▲ A pendant pull station control, a completely new system of control designed specifically for floor-operated cranes, has been announced by the control division of the General Electric Company. Furnished for use on alternating or direct current with motors up to 15 hp at 220 volts, the new control system can be used on cranes ranging in size from simple hoists to three-motion bridges, providing them with the same smooth operation and control refinements as cab-operated cranes.



Several protective features are included in the new system, such as an emergency stop button which instantly cuts off the power from all crane motors.

The new control system consists of a small magnetic control panel mount-

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ed on the crane and connected by a cable to a pendant station which is suspended from the crane. It provides five-point, time-delay speed control for smooth, fast control of the crane movements. Because time-delay acceleration is provided in the pendant pull station, accelerating relays usually found on magnetic control panels are unnecessary, and therefore the size of the control panel is reduced.

The pendant station has one handle for each direction of crane motion. To operate a particular crane motor or crane motion, the corresponding handle is pulled. As the handle is pulled out, the crane motor accelerates to the speed indicated by the position of the handle in the operator's fingers. All crane motions can be controlled with one hand.

The pendant pull station, which weighs only 8½ lb, may be suspended from the trolley of the crane to hang beside the load, or hung at a distance. For stationary hoists, it may be mounted on a rigid support or against the wall.

—11-E-5—

BARTLETT-HAYWARD PLANT BUILDING PRECIPITATORS

▲ Precipitators which will remove either solid or liquid particles from plant discharge gases are made available to American industry by Koppers Company, Inc.

Called the "Koppers-Elex" electrostatic precipitator, the equipment will be engineered and built at Koppers' Bartlett-Hayward plant and will remove boiler fly ash, tar, acid mists, soda ash, fluorides, catalysts, dust, and other nuisances or valuable by-products.

Koppers has accepted a number of orders for these precipitators and has been engaged in the engineering work on them for several months. The Bartlett-Hayward plant is ready to go into production on the first orders for the Swiss-invented apparatus, and it has acquired exclusive manufacturing and sales license rights in North America.

The precipitators are designed for maximum removal or recovery of solid or liquid particles from industrial and waste gases, and are engineered specifically to the needs of individual

YESTERDAY...

The Problem Was Still Unsolved

Steel men know that entrapped hydrogen causes porosity... other more obscure defects... weakens the strength of electric furnace steels. Flushing out the hydrogen with an inert gas seemed the best solution. But what gas? Nitrogen?... Carbon Dioxide?... Carbon Monoxide?... Chlorine?... Helium?... Each was tried... each had its drawbacks. And, in the meanwhile, Airco's research staff was bending every effort to solve the problem.

TODAY...

"Argon Flushing" Is the Answer

Airco technicians soon realized that Argon was the gas the steel industry was looking for. It is insoluble in steel... unreactive... and not only rids the molten metal of hydrogen, but floats the finely disseminated particles of slag, oxides, and other foreign matter to the surface as well.

AND TOMORROW

Airco—producers of Argon, Oxygen and other industrial gases—will continue to contribute to new and better ways of steel production... not only in the direct application of various gases but also in the creation and development of the tools of the future.

Airco's Technical Sales Division is at the call of steel men in applying Airco processes in the solution of their problems. For additional information, get in touch with your nearest Airco office or write: Air Reduction, 60 E. 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas.

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plants to provide any desired efficiency.

The precipitators are especially interesting to industries located in municipalities which have new smoke control ordinances, or where there is a trend toward tightening smoke abatement regulations. They can be used for cleaning gas from blast furnaces, gas producers, and coke ovens.

——11-E-6——

STIRRING MECHANISM AIDS WATER SOFTENING UNITS

▲ Among the mechanical operating improvements to Cochrane precipitation type hot-process water softeners used in the external treatment of water for boiler feed and industrial processes is the development of the stirring mechanism. This agitator creates a rotary motion within the sedimentation tank and brings about an improvement in the floc formation and better sedimentation of the precipitated hardness.

Increased temperature by designing the hot-process softener for higher steam pressure and recirculation of some of the sludge accumulation from the sedimentation cone all contribute to savings in chemical reagents and increasing the efficiency of the softening process by improvement in the quality of the effluent.

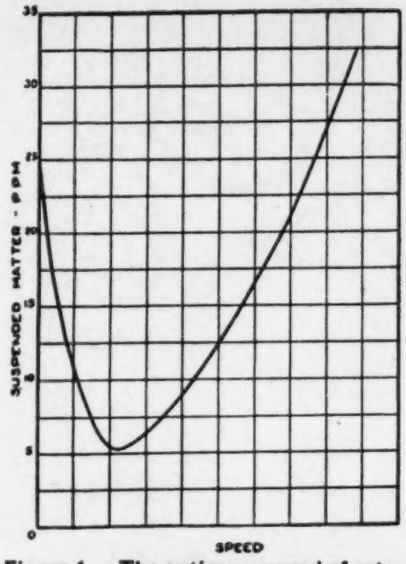

Figure 1 — The optimum speed of rotation for the stirring mechanism is quite pronounced. Turbidity in the effluent may be reduced from 25 ppm without the stirring mechanism to 5 ppm. Increased speeds beyond the critical point result in increased turbulence and improper sedimentation.

The stirring mechanism is a motor-operated device in which a flat blade is rotated at the optimum speed. This speed is dependent on the sedimentation tank dimensions. Figure 1 illustrates the performance of the stirring mechanism and particularly its sharp critical value as to speed. If the stirring mechanism is operated at too high a speed, the tank will be stirred up so greatly as to decrease the efficiency of sedimentation. If the speed is not up to the optimum only partial improvement is obtained.

A number of tests of the stirring mechanism in many Cochrane installations have indicated exceptionally fine performance with fairly hard waters and without supplemental sludge recirculation. With relatively soft waters it is recommended that sludge recirculation be combined with the stirring mechanism because the precipitated hardness may not be of sufficient quantity in itself to properly coagulate the turbidity. The increase in bulk of the precipitate by the

(*Please turn to page 126*)

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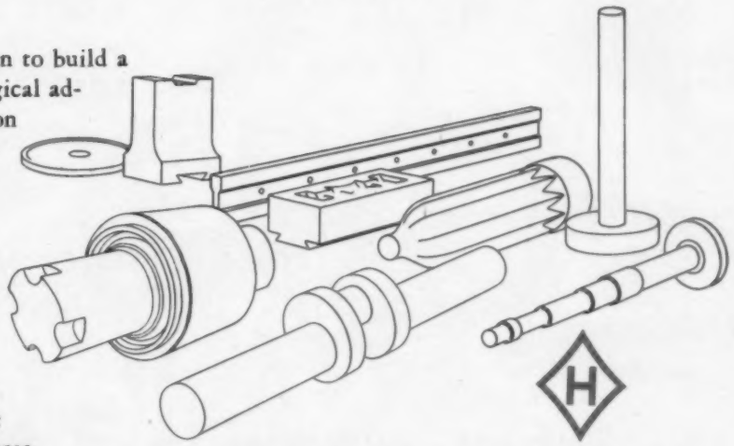

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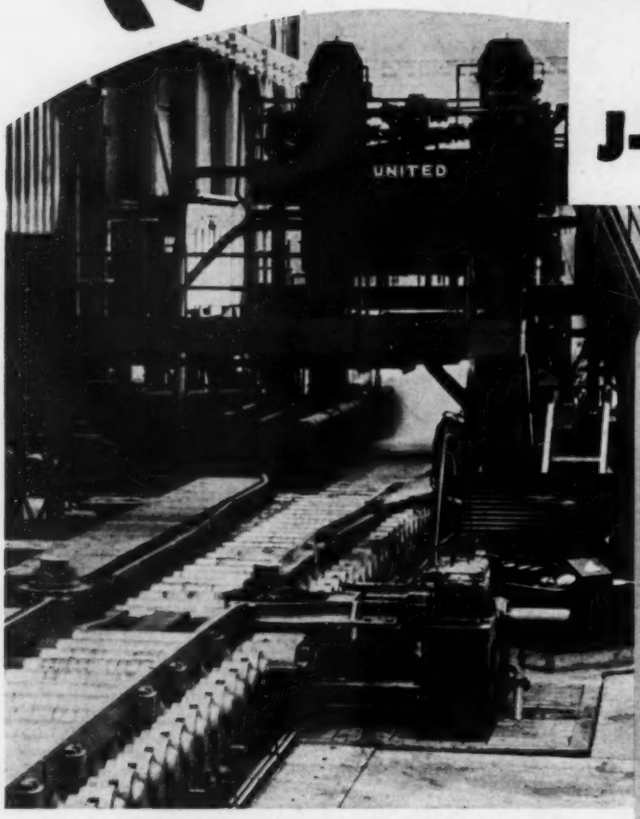
equipped with J-M CLIPPER SEALS



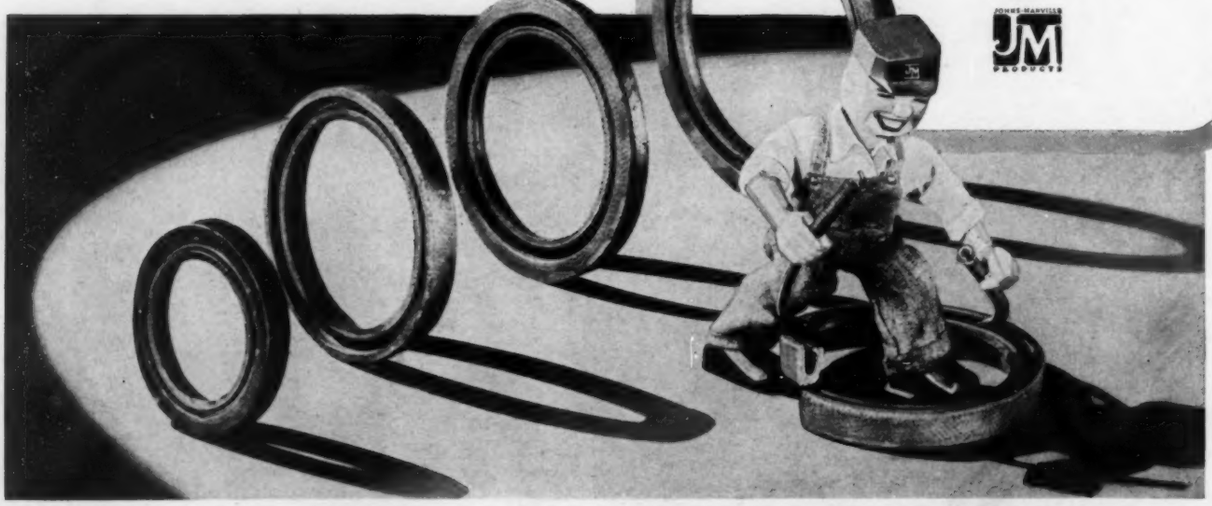
The bearings on this roll table, made by United Engineering and Foundry Co., Pittsburgh, Pa., are protected by Johns-Manville Clipper Seals.

Lubricant stays IN . . . dirt and water stay OUT when bearings on steel mill equipment are protected with J-M Clipper Seals. That's because their one-piece body is concentrically molded for a precision fit. A flexible "lip," held in light but firm contact by a self-adjusting garter spring, effects a positive seal, at the same time reducing wear on the shaft.

Because Clipper Seals are non-metallic in construction, they are highly resistant to most forms of corrosion. Molded of resin-impregnated fabrics and synthetic rubber compounds, Clipper Seals are tough, long-wearing—successfully meet extreme operating conditions. Performance records confirm their ability to outlast other types of oil seals . . . provide better, more economical bearing protection in steel mill service.

For complete details on Clipper Seals, write Johns-Manville, Box 290, New York 16, New York.

JM PRODUCTS



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NOVEMBER, 1946

(1) Balanced Proportions . . .

. . . . is the title of a new booklet that is available to you. The book covers balanced proportioned bearings that are used for steel mill service on mill roll necks, screwdowns, tables, mill drives, pinion stands and auxiliary equipment of all kinds. Included is data on the new bearing which has a radial rating of 310,000 lb at 100 rpm, an increase of over 36 per cent over bearings now being used for the same type of service. The bearing also has a life expectancy 2.83 times as great as its predecessor. The bore is 15 per cent larger, which shows a 36 per cent reduction in neck stress. Timken Roller Bearing Company.

(2) High-Lift Trucks

"The Transtacker" has just been published explaining and illustrating a new high-lift tiering unit which operates as the motorized hand truck counterpart of fork and platform lift trucks. Sketches and photographs show the operation and construction of the Transtacker's four models which are designed to tier, detier and transport unit loads on all types of pallets and skids. Dimensional specifications, weights and load capacities of the industrial truck are given in line drawings. Technical data gives a summary of the operation and construction of the various components. Automatic Transportation Company.

(3) Asbestos Cables

A new bulletin describing the principal types of Okobestos heat and corrosion resistant wires and cables has just been issued. It has been prepared to furnish an over-all picture of a group of products each insulated with impregnated felted asbestos and designed to transmit electrical power uninterruptedly where high temperatures are encountered in continuous service. Among the types of wires and cables described in this reference bulletin are power cables, apparatus cables, multi-conductor control cables, switchboard wires and appliance wire. Included is detailed information about all principal standard Okobestos constructions as well as the voltages, operating temperatures and work locations. (OK-2061). Okonite Company.

(4) Air-Draw Furnaces

A booklet has been issued which illustrates and describes an improved "Rotair" recirculating air-draw furnace. These furnaces are gas-fired and especially designed for heat treating below 1250 F. High velocity circulation of hert gases in this unit gives accurate and uniform temperature control in very dense loads. The booklet covers operating data, sizes and specifications in detail. (D-9-12-45). Eclipse Fuel Engineering Company.

(5) Pump Valve Service

At a time when materials shortages and transportation problems complicate procurement of new equipment it is of interest to note that many old pumps have been rehabilitated or adapted to new types of service by fitting valves. A new catalog has just been published designed to illustrate the wide application of Durabla valve units for reciprocating pumps and diesel engines. The applications illustrated in this catalog are primarily on pumps and diesel engines which use Durabla valve units as standard equipment, but the details presented not only provide a summary of the design characteristics of Durabla valves but also indicate their adaptability for use as replacement units on any type of reciprocating pump. (920). Durabla Manufacturing Company.

(6) Educational Program

Much confusion and discontent so prevalent today can be corrected best by understanding the facts and basic principles of our machine age economy. To get this message to both management and workers of industry the DoAll Company has inaugurated an extensive educational program. This program anticipates the cooperation of management in the free distribution of educational pieces. Included in the group is a book "Your Life in the Machine World" by Leighton A. Wilkie, and a wall chart showing the history of the Machine Age. The material included is adaptable for use in group discussions, for plant libraries, and for distribution to employees. Much thought has been given the preparation of the material offered by DoAll. We suggest that all persons concerned with the supervision of large groups of individuals obtain a copy of this educational program and study it to see if it would not prove of value. DoAll Company.

(7) Induction Heating

Induction heating and melting are described in a new booklet entitled: "Melting and Heating by High Frequency." The book describes the principles and advantages, and shows many ways to use high frequency to speed production, reduce costs, and hold closer tolerances in melting, heating for forging, brazing, annealing, and countless other jobs. Of particular interest are data to assist in proper selection of equipment. (27). Ajax Electrothermic Corporation.

(8) Strip Steel Mill

. . . is the title of a reprint from the September 1946 issue of "Lubrication" that is available to you. This article discusses hot strip rolling; cold reduction; centralized lubrication; pressure grease lubrication; and oil circulation. The paper includes a discussion of the various phases of lubrication, particularly where high rolling speeds are concerned. Charts are included showing the proper lubricants and facilities to improve lubrication. It tells how the lubrication engineer in the steel mill has become an important personage, as he must be an authority on bearing materials, methods of lubrication, and means for preserving the lubricating ability of oils in service. Texas Company.

(9) Atomizing Deaerators

A booklet on the atomizing type deaerator is available describing completely operation, construction, and applications. In the deaerator described, the incoming water is first heated practically to saturated steam temperature by being sprayed in direct contact with steam. After this initial heating the water contacts a high velocity steam jet which finely divides or atomizes it and which scrubs away the noncondensible gases. The high velocity steam jet is established by causing the incoming steam to pass through an opening or orifice which sets up a pressure drop of ½ to 1 psi. Included in the book are descriptions of the types of designs for industrial plants, and a description of these deaerators as integral parts of hot process softeners. (4160). Cochrane Corporation.

(10) Cooling Towers

A catalog is available completely covering atmospheric type aerators and mechanical draft type counterflow cooling towers. The selection of cooling towers, variables which affect cooling tower size, and descriptions of the various types manufactured are included in this book. A discussion of pulsation dampeners is given. Typical applications showing the economies effected in maintenance and original plant cost will also be found. The subject of cooling water is thoroughly discussed throughout the publication. (46). The Fluor Corporation, Ltd.

(11) Pump Packing

A booklet is available giving complete instructions on the selection and correct installation of the proper packing for each size pump and type of service. Written specifically to apply to Durcopump, a corrosion-resisting pump, the information in this booklet is also applicable to all chemical or corrosion-resisting centrifugal pumps. It includes information on special stuffing box arrangements, such as, liquid seal, lubricant seal, recirculating seal, rotating metallic seal. It also deals with slurry problems and the handling of high suction heads. (813). The Duriron Company, Inc.

(12) Heat Loss Control

In a new manual for process engineers and power men, "Control of Industrial Heat and Power Losses", nine case histories are given of fuel cost savings resulting from proper insulation of piping, flanges, drumheads, driers, boilers, and other hot surfaces. Typical applications are described in detail, with simple formulas for determining heat-losses, and tables of necessary data for using the formulas. This material is supplemented with a "Heat Loss Estimate Sheet" for the reader's use in calculating heat losses from his own equipment. Industrial Mineral Wool Institute.

(13) Bus Ducts

To aid in the selection and application of a bus duct system to provide flexible, accessible power in industrial plants, a new data book has been prepared. The new booklet diagrams and analyzes step by step three typical bus duct installations. Drawings and photographs of the duct components illustrate the ease of installation, sturdy construction and trouble-free design of the equipment. The engineering data section of the booklet includes standard ratings of main breakers, temperature conversion tables, formulas for determining amperes, horsepower, kilowatts and kilovolt amperes, and load power factor curves, and other information designed to aid in correctly applying bus duct, and in selecting power take-off devices. (B 3714). Westinghouse Electric Corporation.

(14) Universal Tester

A book has been prepared discussing the new "Model K" universal tester which is capable of testing for tensile, compression, transverse or shear. The book tells how this new conception in testing technique is highly portable, easy to operate, light in weight, and economical. Descriptions of various types of testing methods are included. W. C. Dillon and Company, Inc.

(15) Synchronous Motors

The how, why, when and what of modern synchronous motor control are detailed with more than 45 diagrams and photographs in "The ABC of Synchronous Motor Control" which is available to you. Subjects covered are: How the synchronous motor starts; how polarized field-frequency control works; spread-out connection diagram; selection chart for control; magnetic full-voltage control description; magnetic reduced-voltage control description; magnetic part-winding control description; and magnetic "Hi-Fuse" combination control description. (EM Synchronizer, Vol. 7, No. 3). Electric Machinery Manufacturing Company.

(16) Abrasives Handbook

A handbook on abrasives and grinding wheels is yours for the asking. The contents of the book are: abrasives and grinding wheels; constant, variable and influential factors, grinding examples, reference tables, handling storage and inspection, general operating rules, grinding hints; diamond wheels; definitions; and grinding wheel recommendation and selection table. The grinding wheel recommendation and selection table is based on actual successful use in field production work. (1508-10P). Norton Company.

(17) Ball Bushings

A new booklet is available describing newly developed ball bushing for linear motions. Operating principles and features are explained and the 20 advantages ob tained by the use of ball bushings are given. Listed are the 17 sizes of standard ball bushings ranging from ¼ in. shaft to 4 in. Sizes from ¼ in. to 1 in. vary in ⅛ in. steps; from 1 in. to 3 in. in ¼ in. steps and from 3 in. to 4 in. in ½ in. steps. The booklet gives all standard dimensions, installation data and load ratings. Special designs of the ball bushing are indicated and fields of application suggested. Thomson Industries, Inc.

(18) Hooker's Bible

A handy computer, designed to give hookers an accurate yardstick with which to determine the maximum safe load that a sling chain can lift at any given angle, has just been produced. The hooker sights through the window of the computer on one leg of the sling chain. He then moves the needle of the computer to line up with the leg that is sighted. The angle of the chain is read at the end of the needle. The safe working load for the size chain being used may then be found on the scale of the opposite side of the computer. The safety sling computer is printed on plastic and can therefore be kept clean for easy reading. S. G. Taylor Chain Company.

(19) Belt Conveyor Idlers

A new bulletin on the Rex belt conveyor idlers is available. The first section of the book is devoted to the proper selection of idlers. Then follows a large two page cutaway illustration showing details of construction. After the description of the complete line of standard idlers, appears a section on special application idlers, followed by description of accessories. (464). Chain Belt Company.

(20) Power Brushes

"How to Select Power Brushes for Manufacturing Operations" is a booklet that is available to you. Selecting the right power brush from the many types and sizes available for a particular manufacturing operation may appear to be complicated, but if a few brush characteristics are considered step by step the selection is not difficult. This booklet endeavors to cover all the various factors that enter into selection specifications and the adjustments of these specifications to fit the job the brush is to perform. The Osborn Manufacturing Company.

(21) Production Testing

A new series of illustrated data folders covering laboratory and production testing machines which simulate altitude conditions including sub-zero, cold, relative humidity and vacuum conditions are available to you. Among the data folders are: Utility units for rapid dependable production testing between plus 158 F and minus 90 F; relative humidity simulation units; high altitude simulation; and laboratory units. Bowser, Inc.

(22) Indication and Control

Remote indicating and control systems, what they are and what they are capable of accomplishing, are explained simply and concisely in a new engineering bulletin. How the transmitter, receiver and indicator of such systems are constructed, how they work, their important advantages and specifications are graphically presented with diagrams, charts and photographs. According to the bulletin, direct current remote indication and control systems manufactured by this company have been used with complete success in a great variety of applications. Although basically a direct current device, the system is extremely flexible in application because it can be easily operated on alternating current by the addition of a small rectifier unit. (14B6641). Allis-Chalmers Manufacturing Company.

(23) Permanent Molds

A new book just published gives what is probably the most comprehensive story of the permanent mold process ever published. The procedure used in preparing the molds from the drawing board through the various stages to the finished and tested mold, is shown in detail. Another section of the book covers the permanent mold

process of producing gray iron castings with the Eaton machine. A discussion of the physical and mechanical properties of permanent mold gray iron and some suggestions for designing products for the process. Eaton Manufacturing Company, Foundry Division.

(24) Thickness Gage

Data is available to you on a remarkable new gaging instrument known as "Measuray" which utilizes an entirely new X ray and electronic application for non contact, continuous or spot checking of thickness of all types of moving materials. The "Measuray" can be applied to almost any production process where it is desired to measure and regulate the thickness of material. Accuracy can be held to better than one per cent of material being checked if required. Speed of movement of material has no effect on the accuracy of this gage. Sheffield Corporation.

(25) Stationary Tachometer

A bulletin describing the largest stationary tachometer made in America is available to you. The bulletin shows how these instruments, which come with 8 in., 10 in. and 20 in. dial, are primarily designed for heavy duty, long lasting service and have visibility from a distance. Sectional diagrams are included showing the method of internal operation. (798). Herman H. Sticht Company, Inc.

(26) Roll Turning Tool

A data supplement is available to you describing a line of broad nose tools for turning cast iron rolls up to 90 Scleroscope. According to the supplement, preliminary performance reports indicate major savings in production costs can be effected with these new tools. For example, a roll that required 25 hours for rough grinding was turned with two 8 in. Kennametal tools in 8½ hours. Kennametal roll turning tools comprise solid "Kennametal Grade K6" blades, securely held in position on an accurate surface of the supporting shank by a clamp and serrated, advanceable back up plate — each of heat treated steel. (Supplement 1 to Catalog 46). Kennametal, Inc.

(27) Water Column Trycocks

A bulletin is available describing water column trycocks which are seal-tight. The folder gives details, diagrams, sizes, and prices. Also available to you is a copy of a periodical magazine issued by this company which gives interesting technical data on all types of piping equipment, valves, water columns, and gages. (WG-1815 and YARWAY NEWS). Yarnall-Waring Company.

(28) Flexible Couplings

A bulletin on flexible couplings is available to you. The bulletin describes the design of these couplings which have a positive and consistent transmittal of torque without power loss due to inefficiency of the coupling. Included is a description of the installation and operation of these couplings. (461). American Flexible Coupling Company.

(29) Insulation

"Insulating Varnishes and Compounds" is the title of a catalog that is available. This 56-page informative booklet contains many helpful tables, charts and articles, all compiled for the purpose of providing a worthwhile approach to any insulating varnish problem. It is a handy reference for many problems, such as the selection of insulating varnishes and compounds, and the thinning of insulating varnishes. John C. Dolph Company.

(30) Stud Welding

"Stud Welding Hearth Doors" is the title of a book on increasing the life of hearth doors and cutting the repair time. The book tells how this stud welder automatically end-welds studs to metal; and how complete fusion of studs to metal results from flux-filled studs, automatic timing control, and a full-shielding of the arc. Nelson Specialty Welding Equipment Corporation.

(31) Induction Motors

A new bulletin covering standard squirrel cage induction motors is available. The motor is described completely including the design features; insulation; standard and special mountings; typical applications; and other pertinent data. (720). Louis Allis Company.

(32) Electric Hoist

A catalog on the "Cable King" wire rope electric hoist is available to you. The catalog contains data on air-cooling, construction, parts, and descriptive specifications. Dimensional diagrams on the various sizes of electric hoists are given together with dimensional data. Also covered are the accessories and the hoisting speeds. (W-39). The Yale and Towne Manufacturing Company.

(33) "Electrolytic Tin Plate"

...is the title of a technical article that has been prepared in book form with appropriate illustrations. It is available to you. The article covers processing equipment common to all electrolytic tinning lines; entry and equipment; exit and equipment; electrical equipment; and other data pertinent to electrolytic tinning. Recommended to all steel mill engineers and operating executives interested in the finishing of sheet and tin plate products. Wean Engineering Company.

(34) Vibration Insulators

A new booklet on "Vibro-Insulators," devices of rubber and metal to cushion industrial and manufacturers original equipment and reduce vibration and noise, is available to you. The booklet includes descriptions of three new insulators recommended for use as feet or bumpers on blowers, fans, and pumps. All the insulators provide quieter operation, greater stability of equipment and vibration absorption. The book gives an outline on the proper selection of the insulator for specific requirements, cites a larger number of typical applications and gives a complete table of characteristics of each type. B. F. Goodrich Company.

(35) Die Casting

An instructive folder on a new design of full-hydraulic, fast operating cold chamber die casting machines is available. The principles of "Hydrocast" die castings are discussed in detail and diagrammed in three typical stages. Illustrations and close-up views describe the essentials of progressive die casting. A specification chart hows which model is best suited for given production jobs. (L-24-D). Hydropress, Inc.

(36) Disconnect Switches

A new bulletin describing magnetic safety disconnect switches for d-c cranes has just been published. The bulletin gives complete information on the ratings, dimensions, etc., of the four available sizes. The folder describes the manner in which these switches disconnect the crane from

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the main collector power-feeders running along the crane runway. Being of the magnetic type it is easy for the operators to open or close these disconnect switches. (1024). Electric Controller and Manufacturing Company.

(37) "Operating Characteristics

. . . . of Lead Acid Storage Batteries" is the title of a reprint of a technical article that is available to you. The paper covers the important points, (a) that the battery be able to deliver power at the required rate in amperes and at a satisfactory voltage; and (b) that it be able to deliver this power for the required length of time. Particular reference is made to batteries used for motive power purposes and while the general statements made are applicable to all types of lead-acid batteries, the specific data given will be confined to the type of battery used in electric industrial trucks and tractors. (209). Electric Storage Battery Company.

(38) Oil Atomizer

A unit oil atomizer designed to provide atomized oil for burners of small capacity is described and illustrated in a new bulletin. The bulletin discusses the unit atomizer which provides an oil application for small gas burners or a multiplicity of small oil burners served by a preheated air system. Operating on high pressure steam, the atomizer creates a steam-oil emulsion and dissipates it to the burners. The new bulletin features a typical unit atomizer system layout with complete descriptions of capacity and operation. Bloom Engineering Company.

(39) Roller Bearings

Just issued is a new catalog, available to you, which introduces a new numbering system for all inch series steel cage type bearings. The new numbering system definitely identifies the size of the bearing in units of one-sixteenth of an inch. The whole number consists of six digits, the first two digits designating the bore; the second two, the roller diameter; and the last two, the length. The catalog also presents the company's steel cage type solid cylindrical roller bearings in the present available sizes. The information in this catalog is intended for general industrial application. (540-C). Rollway Bearing Company.

(40) Lubricant Film

"Lubriplate" was developed to meet the requirements of modern industry and to effect economy as well as improvement in machine operation. How this is done is told in a new bulletin available to you. The catalog tells how the lubrication of old machinery can be solved by the use of this new lubricant. Many old machines that might otherwise be discarded have been found to operate with new efficiency with this remarkable lubricant. Bearings will last longer, according to the bulletin, and the machine can speed up beyond original rates. Lubriplate Division, Fiske Brothers Refining Company.

(41) Steel Production

"The Ingot Phase of Steel Production" is the title of a book that is limited to supervisory personnel engaged in steel production. This is a revised edition of a book printed in 1937 and 1938 covering that period embracing the operations involved from the finishing of the heat, through teeming, solidification and reheating of the ingot to the initial working in the mill. The Gathmann Engineering Company.

(42) Centrifugal Pumps

A catalog on two-stage centrifugal pumps is available to you describing the industrial uses of these pumps. These pumps, according to the book, are used as condensate service for power plants and general use throughout steel mills. The pumps described are two-stage, ball-bearing units designed to operate at modern motor, turbine and engine speeds. Available capacities are up to 2200 gpm for discharge heads up to 1050 ft (450 lb per sq in.). Catalog contains cutaway views, types of drives, typical installations, and tables of performance, dimensions and pipe friction, and a typical pumping problem is worked out in detail. (7062). Ingersoll-Rand Company.

(43) Retaining Rings

A catalog that highlights new developments in retaining rings used to lock and position moving parts such as shafts, gears, bushings, and bearings is offered to you. The catalog describes the rings that represent a radical departure from conventional rings. Engineering data on various applications of retaining rings are included. Waldes Koh-I-noor, Inc.

(44) Mechanized Sheet Mills

The "combination system" for sheet rolling is discussed in a technical article on mechanized sheet mills that is available to you. The article discusses the application of continuous furnaces to a sheet or tin mill and gives the requirements that must be met by pair and pack furnaces. The article includes information on sheet products being produced on these furnaces and mechanized mills which include common black sheets for galvanizing purposes, full finish sheets for auto body, enameling stock and electrical sheets. Wean Engineering Company.

(45) Recuperators

"Recuperators for Industrial Furnaces" is the title of a new publication that is available to you. The publication describes the use of silicon carbide refractory heat transfer tubular elements in all recuperator applications to furnaces operating at high temperatures. Cutaway and diagrammatic views of applications, curves showing savings and low leakage values, plus detailed descriptions are included in this excellently prepared book. (13). Fitch Recuperator Company.

(46) Space Heating

Now is the time to think of next winter's heating problem, and a booklet is available to assist you in your thinking along these lines. The booklet, entitled: "Direct-Fired Efficiency," explains the high efficiency of direct-fired warm air heating, and tells how this economical heater is especially adapted for providing a simple and logical method for heating buildings with large, unobstructed areas. Their simplicity is reflected in low installation and operating costs. (514). Dravo Corporation.

(47) Lighting Switch

Every once in awhile something really and truly new comes along. There is available a bulletin announcing the new oil immersed "Type 800" lighting switch. The bulletin tells how industrial demand for a rugged lighting switch which provides safety, dependability, minimum maintenance and positive operation for use in locations where atmospheric conditions are adverse, has been met by this company's engineers with this new switch. These switches, according to the bulletin, are available in 6 and 12 gang single circuit panels of 125-250 volt a-c, 3 wire main. Rowan Controller Company.

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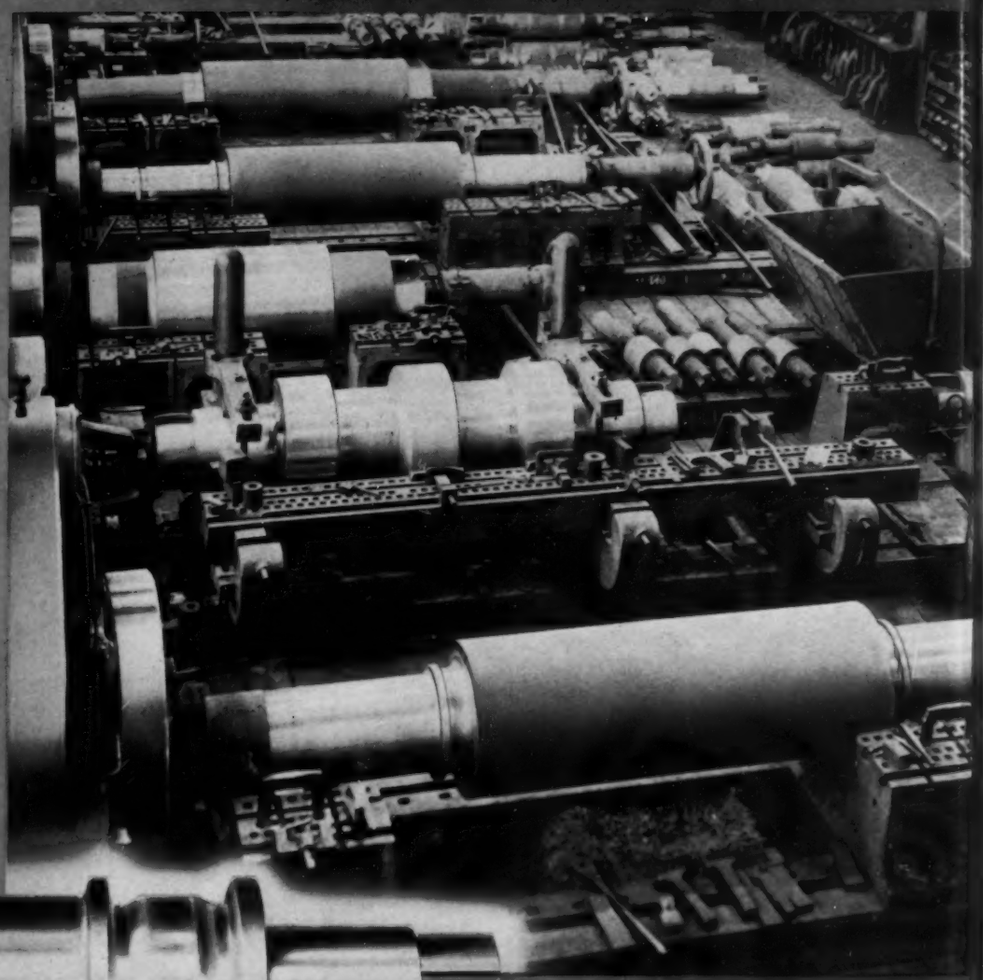

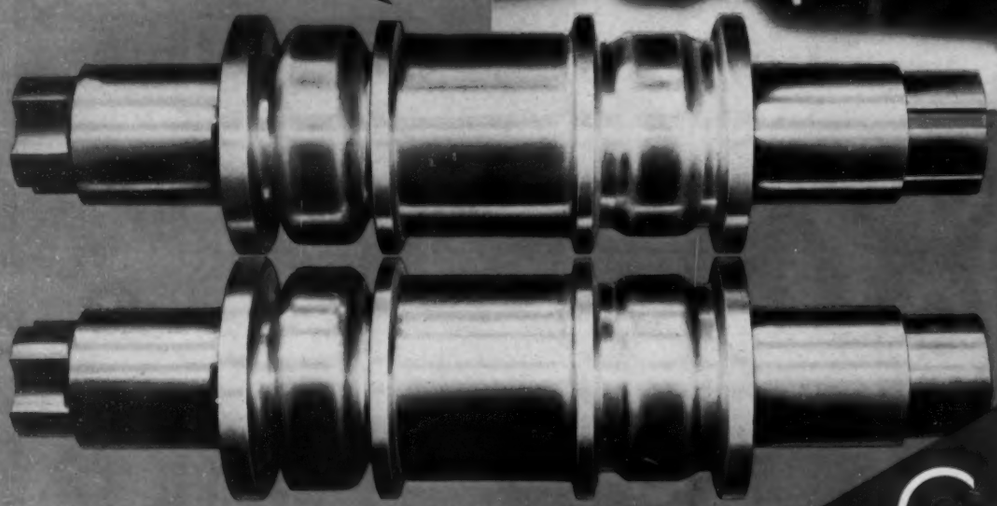

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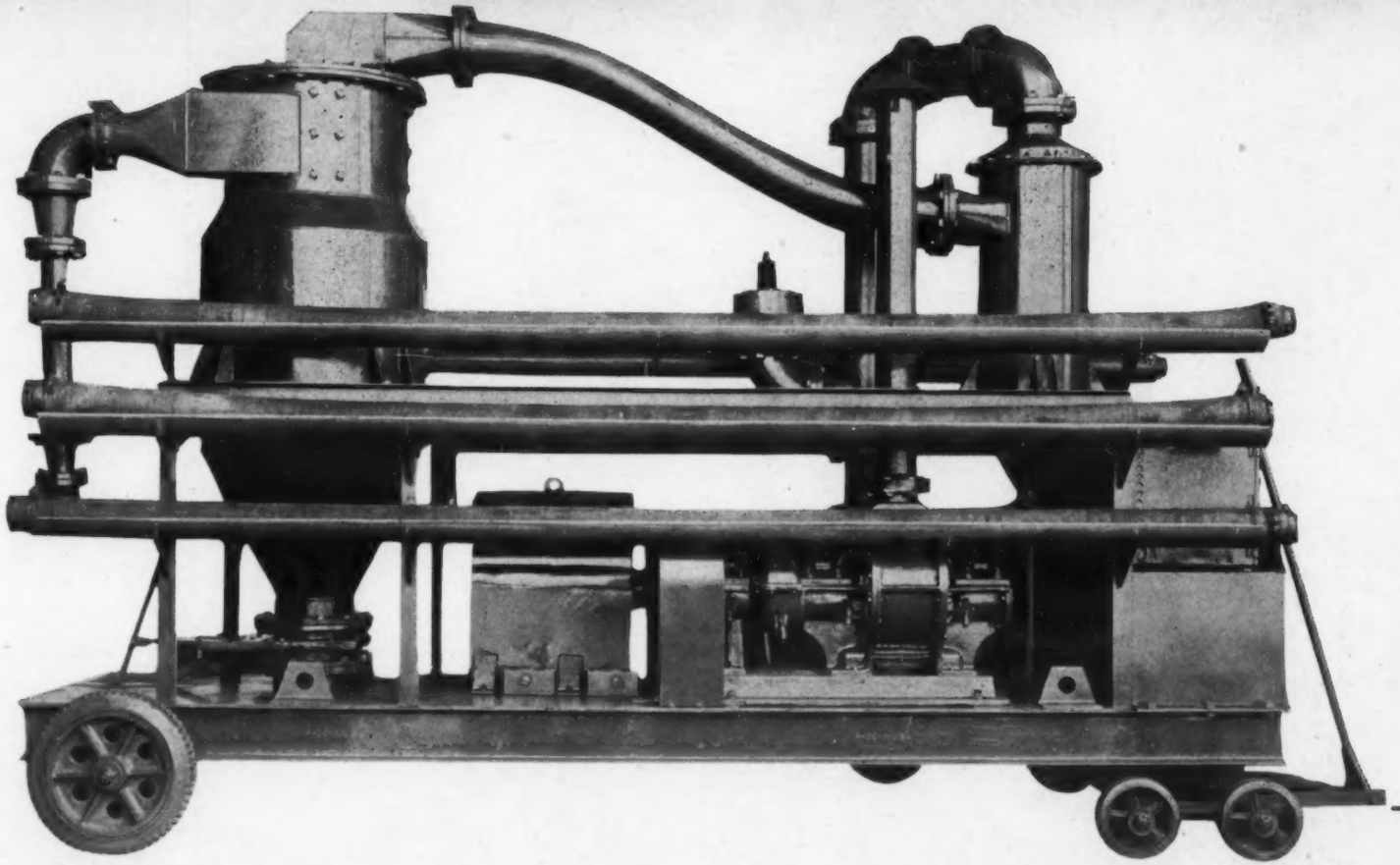

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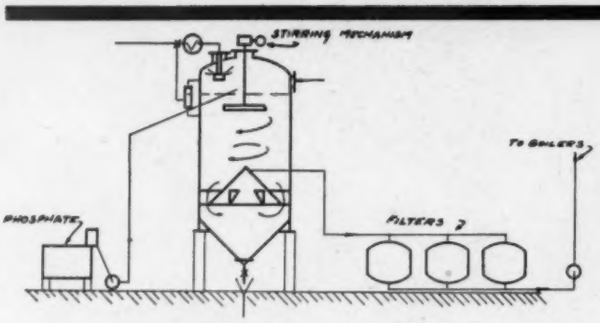

Figure 2 — Stirring mechanism speed depends on sedimentation tank diameter.

(*Continued from page 116*)

additional recirculation of accumulated sludge is necessary for thorough clarification.

Figure 2 illustrates the Cochrane stirring mechanism assembly as applied to a hot-process softener. The shaft is installed through the head of the sedimentation tank. In a typical installation of a 160,000 lb/hr deaerating hot-process softener, at a plastics-fibre plant, hardness in the raw water amounts to 400 ppm (parts per million). The softener is provided with a stirring mechanism only without sludge recirculation. Quantitative tests on the installation when operated at rating indicate a reduction of turbidity down to 5 ppm or less. Without the stirring mechanism turbidity of 20 to 25 ppm would not be uncommon.

—11-E-7—

BRODEN CHANGES NAME TO WEAN EQUIPMENT

▲ To more readily identify its ownership and products, strip steel and wire mill equipment, stockholders of The Broden Construction Company, Cleveland, Ohio, have changed the name of the company to the Wean Equipment Corporation.

Wean Equipment Corporation's physical properties include the entire, completely equipped plant of the former Broden Construction Company and, in addition, all buildings, machinery and facilities originally furnished by the Reconstruction Finance Corporation to meet Broden's wartime needs. These plant facilities now give the Wean Equipment Corporation over 50,000 square feet of building area well equipped with the most modern machine tools, cranes and assembly area for the production of strip steel and wire mill machinery for domestic and foreign customers.

—11-E-8—

NEW WELDING ELECTRODE FOR HIGH SULPHUR STEEL

▲ A new electrode which greatly simplifies the welding of high sulphur, free-machining steel and of certain high tensile, low-alloy steels, is announced by the Lincoln Electric Company.

The new electrode, known as

CRANE BUILDERS Since 1903

BEDFORD CRANES

Capacities 5 to 150 Tons

Any Span or Lift
Send For Your
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Designed and Engineered to Meet Your Requirements

ELECTRIC OVERHEAD TRAVELING CRANES
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DRAFTSMAN —

Experienced design and checking steel mill and heavy machinery.

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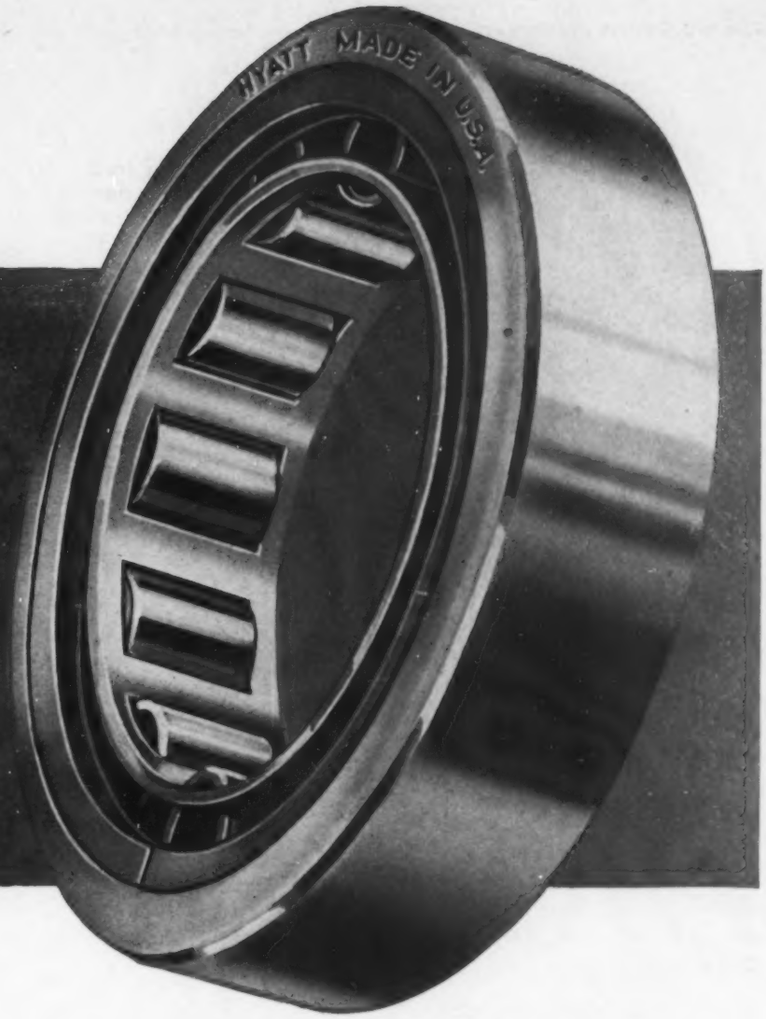
THROUGHOUT ALL INDUSTRY

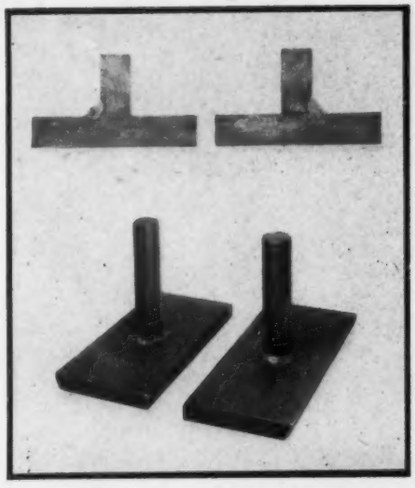


From A to Z — automobiles to zippers. Wherever things are made, handled or transported, there you will find Hyatt Roller Bearings easing the turning of wheels and shafts.

And Hyatt Roller Bearings have for fifty-four years enabled machine designers, engineers and manufacturers to speed up production — cut maintenance costs and reduce friction to a minimum.

So many types of Hyatts are available that it can be stated with confidence — there is a Hyatt Bearing for every application. Consultation on your bearing problems does not obligate you. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS



The new electrode makes possible a weld in less time on a number of types of steel.

"Shield-Arc LH-70," has a low-hydrogen, low-moisture coating and is designed for use with d-c polarity as the welded tensile properties are 70,000-80,000 tensile strength and elongation is 25 to 30 per cent. Welding currents used are high in comparison with other all-position-type electrodes. For example, approximately the same current is used with $\frac{5}{32}$-inch LH-70 as with $\frac{3}{16}$-in. size in other all-position electrodes. The range is: $\frac{1}{8}$-in., 100 to 135 amperes; $\frac{5}{32}$-in., 140 to 190 amperes and $\frac{3}{16}$-in., 180 to 250 amperes. A rather short arc is recommended.

—11-E-9—

EDUCATIONAL PROGRAM FOR PLANT DISTRIBUTION

▲ In a long-range educational program aimed to counteract tendencies toward a decline of free enterprise, L. A. Wilkie, machine-tool builder and chairman of the DoAll Company, warns that "government, industrial management and labor must all combine to protect free enterprise from inroads of economic planners in order to maintain the benefits of this expanding era of progress and potential plenty.

To get his message to both management and workers of industry, Wilkie has inaugurated an extensive educational program backed by the DoAll Company. This program anticipates the cooperation of management in the free distribution of educational pieces. Commenting on this method, Wilkie says, "Telling the facts on which industry is built, is the most potent force to neutralize crackpot philosophies that cause present-day confusion."

Cooperation on this educational program is invited from all plant executives.

—11-E-10—

ALL-IN-ONE SUB-STATION UNIT BUILT BY WAGNER

▲ High voltage incoming line, transformer, and low voltage feeder sections are combined in one compact assembly in the new "all-in-one" unit substations built by Wagner Electric Corporation. Installation is simpli-

GRID
UNIT HEATERS
LAST AS LONG AS THE PIPES FURNISHING STEAM TO THEM . . .
WITHSTANDS STEAM PRESSURES UP TO 250 LBS.
HIGH TEST CAST IRON HEATING SECTIONS

. . It's the material that makes the difference. All GRID manifolds and "fin" heating sections are of the cast type made in one piece of high test alloy cast iron of the same composition as is used in steam tight vessels for high pressures. In them there are no soldered, brazed, welded or expanded connections to become loose or develop leaks. Neither can electrolysis that causes corrosion, breakdowns, leaks, or heating failures develop. The entire construction is designed and built for long life, and designed to provide greater number of air changes at lower outlet temperatures. Because of their design they may be installed higher than other units. In many plants GRID Units have been operating continuously for 16 years without maintenance. Capacity tables and complete details upon request.

D. J. MURRAY MANUFACTURING CO. WAUSAU WISCONSIN

Another CONTRIBUTION

THE HOLZWORTH "SPLIT-NOSE" Tuyere — U. S. Patent 1,789,870 — is giving great satisfaction to blast furnace operators because it CAN TAKE IT in these days of bad coke. It can stand up longer, consequently tuyere costs are lower. This is due to the fact that its design forces a continuous down air blast, thereby eliminating air eddies that allow pools of molten metal to accumulate and burn your tuyeres.

We can serve you promptly, as we have the exclusive license to make and sell this tuyere.

Makers and distributors of Falcon "ANCHORLESS" Cooling Plates, Hot Blast Valves and Seats, Monkeys, the following special tuyeres: Butler-Henry Heavy Nose, Falcon Shrouded, Beaton-Ledbetter, Fleisch Safety, Kinney Heart-Shaped, Steinbacher Angle Flow and Beaton Refractory Nose.

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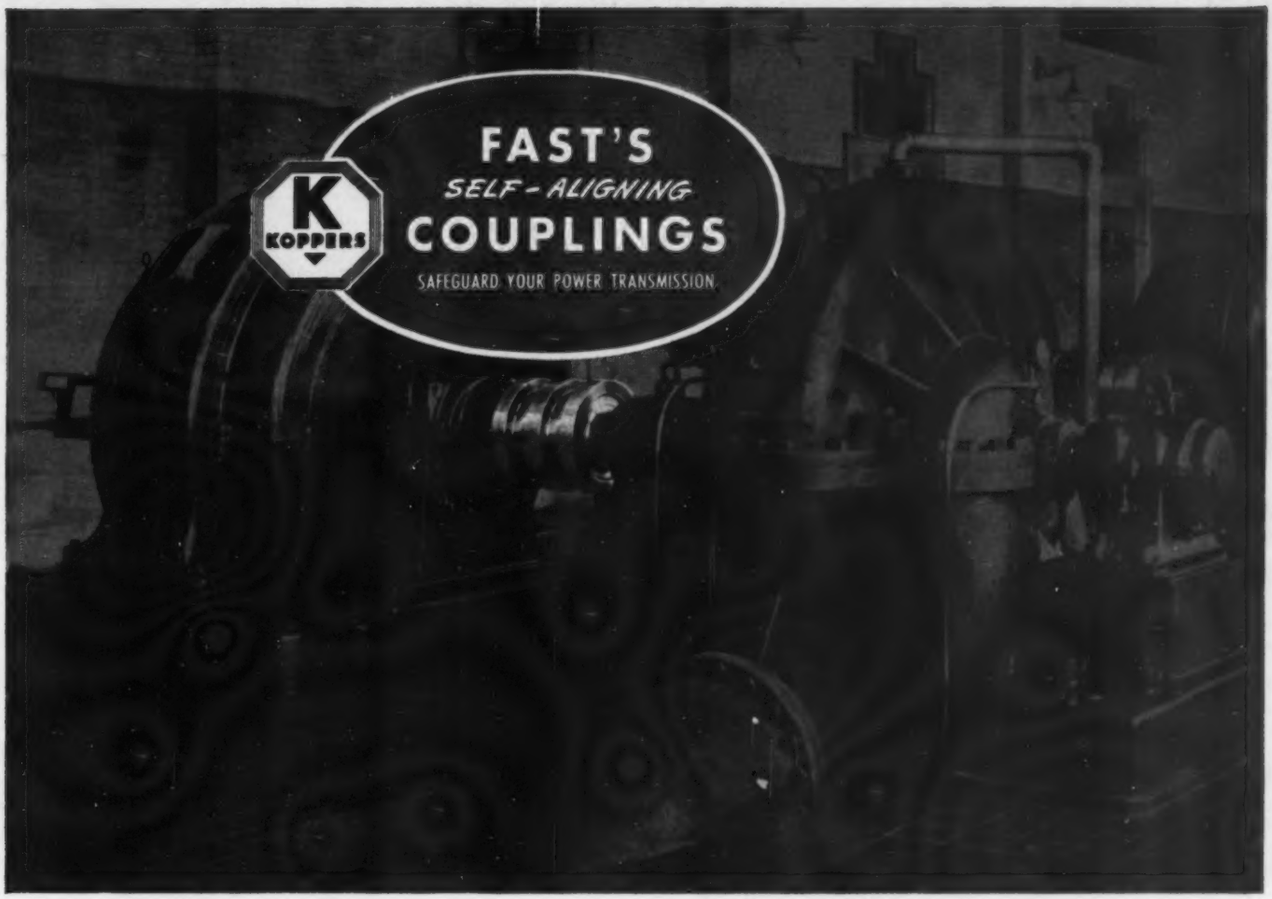


25 years of trouble-free service

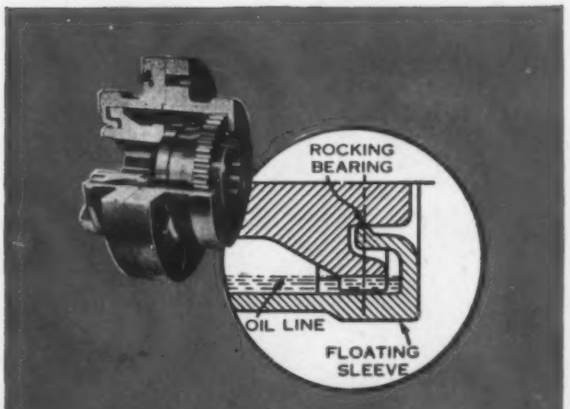
Engineers who have had an opportunity to check performance generally expect Fast's Couplings to last as long as the connected machines. Here's a "Fast's" that has done even better.

This No. 6 coupling was installed in 1921, connecting a 30" pump to a 1700 H.P., 615 r.p.m. motor in a municipal pumping station. Six years later, the first pump was replaced with another, operating at 600 r.p.m. The original coupling was re-installed, and is still serving as dependably as ever.

The company installed three additional pumps in 1933. Naturally, Fast's Couplings were installed on these, and are still on the job.

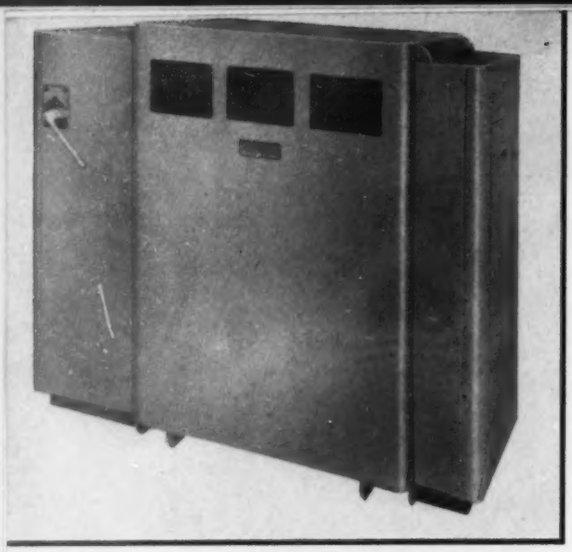
When you choose Fast's Couplings for your power transmission jobs, your choice is supported by the most convincing evidence of all . . . years of trouble-free service in the most punishing applications. Ask for a catalog, which gives complete information.

Koppers Company, Inc., 200 Scott Street, Baltimore 3, Maryland.



Here you see the features that give Fast's Couplings their remarkable dependability. All parts are protected from wear by a positive film of oil. Oil purity is guarded by rocking bearings, located in the one position where they maintain a positive metal-to-metal seal. There are no perishable parts in "Fast's."

K KOPPERS **FAST'S** *self-aligning* **COUPLINGS**



Shown is the completely enclosed construction of the "all-in-one" unit substation.

fied, as the units are delivered ready to connect.

The illustration shows the completely enclosed, streamlined construction of the "all-in-one" unit substation with air cooled transformer for indoor installation. Noflamol (non-inflammable-liquid-filled) or oil-filled self-cooled transformers are also available.

The unit substations are standardized in ratings 100, 150, 200 and 300 kva, 3 phase, 60 cycles. Choice of combinations of different types of transformers and high and low voltage equipment makes them suitable for a wide range of applications.

Book Reviews

▲ A new 76-page technical treatise entitled "G-E Bulletin LD-1," prepared by C. E. Weitz, widely known lamp and lighting authority at Nela Park headquarters of General Electric lamp department is being hailed by many as the lamp user's "bible."

Mr. Weitz's work, in standard 8½ inch by 11 inch size, contains the cream of technical data gathered from a wide range of bulletins and articles published by engineering division of G. E. lamp department. It also features the very latest lamp developments and their practical applications to a host of fields in commerce, industry and the home.

The bulletin is a condensed text on the design and operation of incandescent, mercury, and fluorescent light sources. Its contents page lists more than forty lamp topics, including lamp economics, temperatures, voltages, auxiliary equipments, germicidal, infrared, sunlamps and glow lamps. These topics are presented in such a way on the pages which follow as to quickly answer the majority of questions being asked in their connection. Price: $0.40 per copy.

▲ "Heat Treatment of Carbon Steels" by F. Johnson, has been recently published by the Chemical Publishing Company, Inc., Brooklyn, New York. The price is $4.00 and it provides a brief volume of 204 pages with complete information on heat treatment. This book deals almost exclusively with carbon steels, and it is the first of four books, of which the others will cover alloy steel, cast iron and nonferrous alloys; surface hardening processes, furnaces and pyrometry.

(*Please turn to page 140*)

For Economical Material Handling

JONES SKIP HOIST DRIVES

FOR speedy operation, reliable service and over-all economy the Jones Skip Hoist Drive has made a name for itself in a wide variety of material handling service. These skip hoist drives are built as complete units by the Jones organization in several types with base to take any motor specified by the purchaser. They are equipped for all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double, or triple reduction Jones Herringbone Speed Reducers, built to stand up under the many years of pounding that a skip hoist drive has to take. The shafts are supported in roller bearings, with rolling action, rack generated gear and pinion teeth to insure easiest possible starting with low starting-peak loads. All reducer bearings and gears are automatic oil-bath lubricated.

The Jones organization has an extensive file of information on skip hoist drive problems and will be pleased to work with you on any problems involving such applications.

W. A. JONES FOUNDRY & MACHINE CO.
4431 Roosevelt Road, Chicago, Illinois

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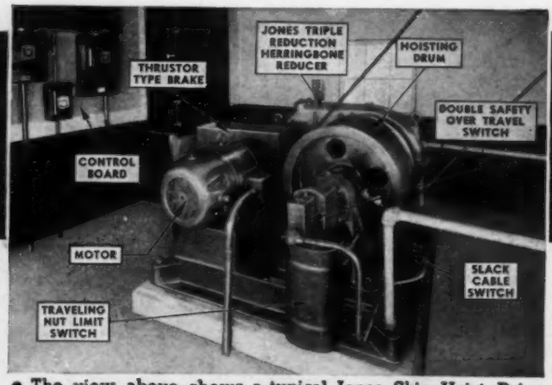
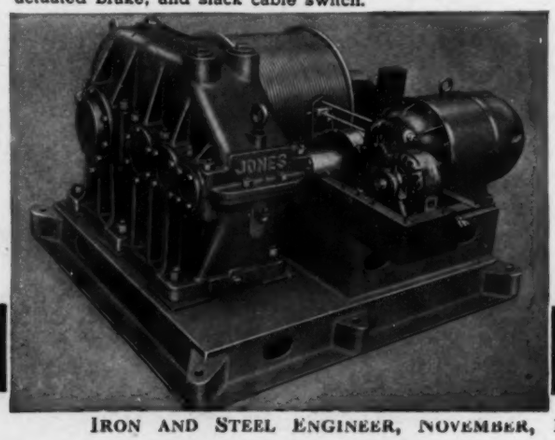


• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.



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"Buffalo"

STAYS ON THE JOB

3 TO 13

TIMES LONGER

There's no magic about the enthusiastic reports coming in concerning the **longer service** "Buffalo" Rubber-Lined Exhausters are giving in thousands of installations. Corrosive fumes destroy metal in a short time, but not rubber! That's why these high-delivery, trouble-free "Buffalo" Exhausters **cost you less** on a year-after-year basis!

If you are investigating ways of cutting fume handling costs, or other air handling costs . . . it may well pay you to write us now for recommendations.

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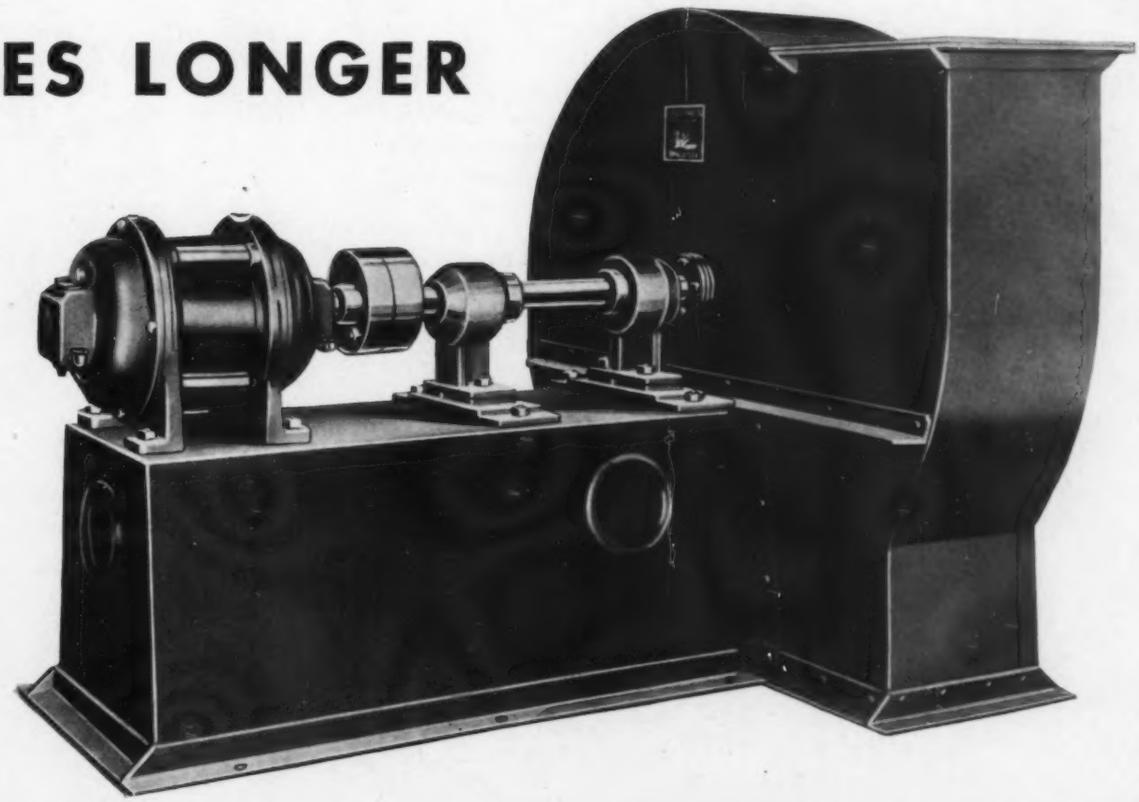
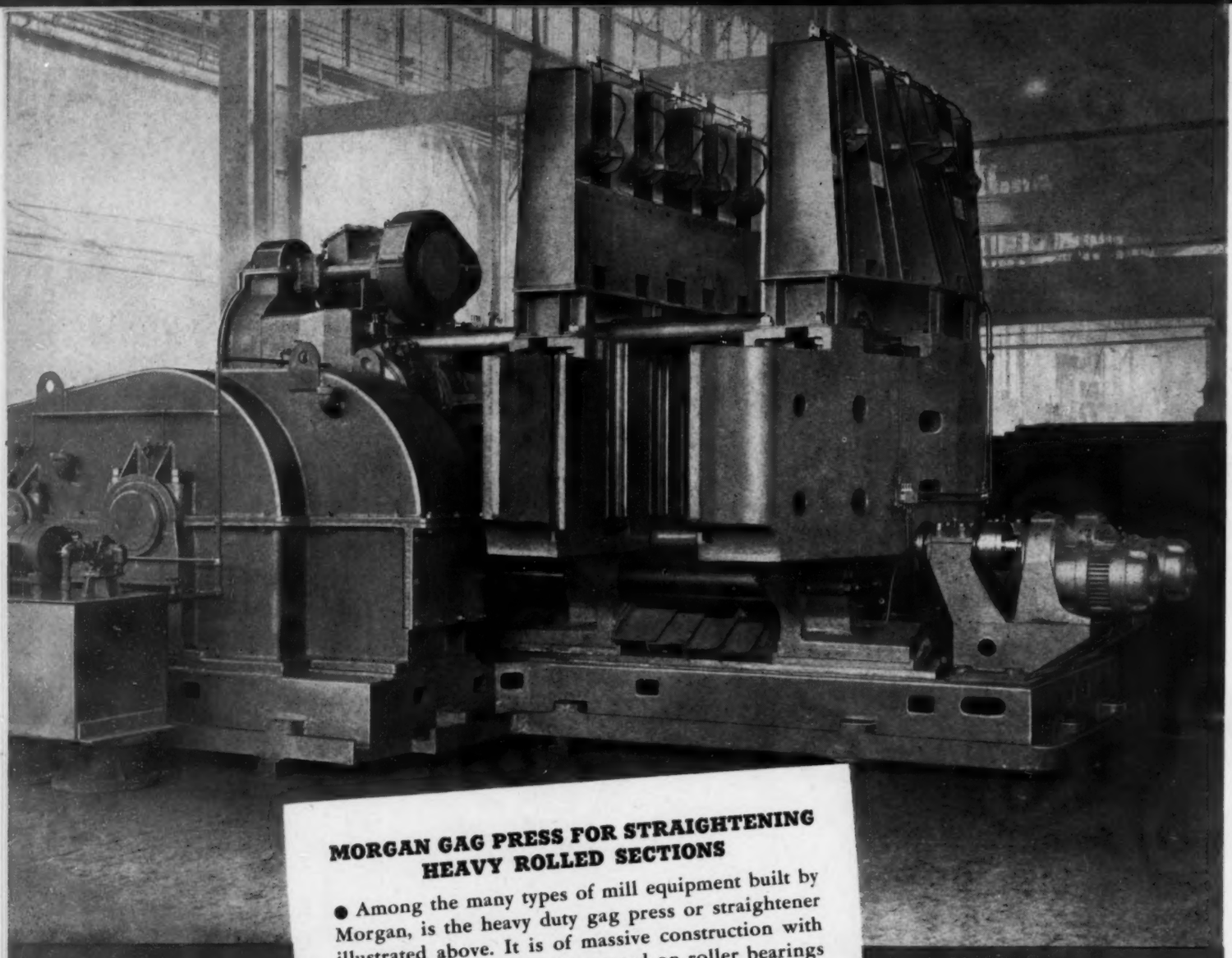
Canadian Blower and Forge Co., Ltd., Kitchener, Ont.



"Buffalo" first for fans

RUBBER-LINED EXHAUSTERS



MORGAN GAG PRESS FOR STRAIGHTENING HEAVY ROLLED SECTIONS

● Among the many types of mill equipment built by Morgan, is the heavy duty gag press or straightener illustrated above. It is of massive construction with drive gears and flywheel mounted on roller bearings and all enclosed in an oil-tight welded housing. All anvil blocks are raised and lowered by individual air cylinders. The two feed rollers are driven by individual motors. This press is typical of the many types of Morgan mill equipment

BUILT BY MORGAN *Engineering*

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Personnel News . . . .

C. R. Dobson was appointed vice president in charge of operations for H. K. Porter Company, Inc., Pittsburgh, Pennsylvania. Mr. Dobson, formerly chief industrial engineer of the Jones and Laughlin Steel Corporation, will supervise operations of the seven Porter manufacturing plants.

Albert T. Lawson was appointed chief industrial engineer for Jones and Laughlin Steel Corporation succeeding **C. R. Dobson,** resigned. Mr. Lawson has been associated with J&L for 30 years, having started with the company in 1916 at its Pittsburgh works engineering department. Since 1930 he has been in charge of the industrial engineering department at the Jones and Laughlin Aliquippa works. Mr. Lawson is a member of the Association of Iron and Steel Engineers.

Marshall M. Smith was elected president of the E. W. Bliss Company at a meeting of the company's board of directors. Mr. Smith will assume his new duties after December 1, at which time **Mr. D. S. Harder,** current Bliss president, will take office as vice president in charge of operations of the Ford Motor Company.

In June 1946, Mr. Smith was elected vice president and director of the E. W. Bliss Company. He will continue to serve as chairman of the board of directors of both E. W. Bliss (England) Limited and the E. W. Bliss Company (Paris) and as director of the E. W. Bliss Company of Canada, Ltd. He joined the company in March 1945.

Mr. Smith has a degree in mechanical engineering from Syracuse University, leaving there in 1917 to join the U. S. Navy, in which he served as an engineer-officer in the Naval Overseas Transport Service during World War I. Upon demobilization, he joined the Foundation Company and worked in their New Orleans shipyard as test engineer and later as assistant to the works manager. After termination of this activity in New Orleans, Mr. Smith joined the Emergency Fleet Corporation, whom he served for several years as port superintendent engineer. Subsequently, he became associated with the Worthington Pump and Machinery Company as sales engineer in that company's New York office, later serving overseas in a sales capacity until 1937 when he became manager of foreign operations and, in 1941, receiving added responsibilities as manager of export sales and foreign operations.

E. A. Irwin has been appointed general sales manager of the E. W. Bliss Company. Mr. Irwin had been the managing director of E. W. Bliss Company of Canada, Ltd., for the past five years, and has been associated with the company for twenty-seven years. Mr. Irwin will be located at the company's executive offices in Detroit.

W. J. Woods has been named purchasing agent of the rolling mill division of the E. W. Bliss Company, Salem, Ohio.

Paul S. Strecker has been appointed director of personnel of the E. W. Bliss Company. Mr.Strecker will direct the company's labor and industrial relations at its five plants located in Brooklyn, New York; Toledo, Cleveland, and Salem, Ohio; and Hastings, Michigan.

W. Earl Dunn, vice president of the Fluor Corporation, Ltd., who has been in charge of the Kansas City office since 1930, has been promoted to the position of general manager. Mr. Dunn will now make his headquarters in the Los Angeles office.

James P. Wiseman, former district engineer in Fluor's Houston office, was appointed general sales manager and is now located in the Los Angeles office.

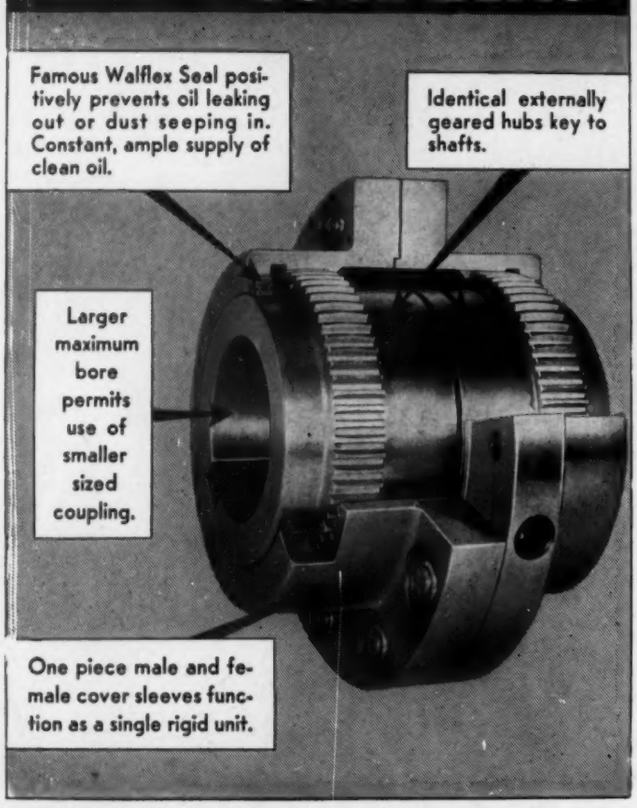
Raymond C. Gintert, formerly superintendent of hot strip rolling at Republic Steel Corporation, Warren, Ohio, will go to Cleveland as superintendent of the Cleveland hot and cold strip mills and will succeed

C. R. DOBSON

MARSHALL M. SMITH

W. EARL DUNN

NEW WALDRON "Series A" COUPLING


Famous Walflex Seal positively prevents oil leaking out or dust seeping in. Constant, ample supply of clean oil.
Identical externally geared hubs key to shafts.
Larger maximum bore permits use of smaller sized coupling.
One piece male and female cover sleeves function as a single rigid unit.

costs *less* to buy, operate and maintain!

By specifying the newly designed Waldron Series "A" Coupling you can select a smaller size than ordinarily required. You save on initial cost, require less shaft extension, insure greater accuracy.

Operating and maintenance costs are reduced by the specially constructed, dependable Walflex Seal that keeps a constant supply of **clean** oil inside the coupling. Many other exclusive construction refinements make the Waldron Series "A" Coupling the most economical to buy and use.

Write for descriptive Catalog 57 giving technical data on various types: Standard, Mill Motor, Floating Shaft, Heavy Duty, Jordan, Cut-Out, Shear Pin, Oil Collector and others.

COUPLING DIVISION

JOHN WALDRON CORP.

Main Office and Works
New Brunswick, New Jersey

COUPLINGS

William Rodgers who was recently appointed assistant chief metallurgist of Republic Steel Corporation.

Mr. Gintert was born in Cary, Ohio, December 5, 1894 and attended schools and business college in Braceville, Newton Falls and Youngstown. He taught school for three years, then became employed in the engineering department of Truscon Steel Company, Youngstown. In 1917 he came to work for Trumbull Steel Company in Warren in the shipping department. He was made general foreman of the 42-inch hot strip mill in 1927 and superintendent of hot strip rolling in 1937. Trumbull Steel became part of Republic Steel Corporation in 1930.

William E. Boger, formerly assistant superintendent of cold strip department, Republic Steel Corporation, Warren, Ohio, was named assistant superintendent of the Cleveland, Ohio, strip mill. Mr. Boger was born in Warren, May 3, 1905 and graduated from Warren High School. He was first employed by Trumbull Steel Company in 1923 in the mechanical department and worked his way up to millwright foreman, master mechanic and assistant superintendent of the cold strip department.

Emil G. McCauley has been named superintendent of hot strip mills, Republic Steel Corporation, Warren, Ohio. Mr. McCauley was born in Struthers, Ohio, March 22, 1903 and attended high school in Niles. He was first employed by Trumbull Steel in 1922 as an open hearth laborer and slager. He worked in numerous departments of the plant and in 1927 was made a foreman on the 14-inch hot strip mill; in 1936 general foreman, No. 1 hot mill; and in July, 1946, assistant superintendent of the Warren hot strip mills.

William Rodgers, formerly superintendent of Republic Steel Corporation's 98-inch hot strip mill in Cleveland, Ohio, has been appointed assistant chief metallurgist of the company.

Mr. Rodgers came to Republic through the Donner Steel Company of Buffalo, which was merged with Republic in 1930. He came to Cleveland in 1940 as chief metallurgist of the Cleveland district and in June, 1945 was appointed assistant superintendent of the hot and cold strip mills and later was promoted to superintendent.

Born in Pittsburgh in January, 1902, Mr. Rodgers attended high school in that city. Later he moved to Erie, Pennsylvania, and graduated from high school there in 1920. He received his college education at the University of Pittsburgh where he was graduated in 1928 with a degree of Bachelor of Science in metallurgy. Meanwhile, he had been employed at the Erie Forge Company, the Halcomb Steel Company, Syracuse, New York, and Carnegie Steel Company and Jones & Laughlin Steel Corporation in Pittsburgh.

He is a member of the Association of Iron and Steel Engineers, American Society for Metals, the British Iron and Steel Institute and other organizations.

S. A. Newman, turbine lubrication specialist recently released from service as a captain in the Navy, has been appointed chief turbine lubrication engineer by Gulf Oil Corporation. He will direct lubrication engineering activities in connection with all forms of turbines in the 30 states comprising Gulf's marketing area.

Mr. Newman joined Gulf in 1930, and advanced to assistant division manager in charge of industrial lubricating sales for the Pittsburgh division. Mr. Newman

DEADENDING

Heavy Feeder Cables

HERE'S a Keystone "hard-to-beat" combination for deadending heavy cables. Long clamping surface provides positive grip on conductor. Note clamp is round and of small diameter to facilitate taping and is free of sharp projections which might pierce tape insulation. In combination with the Keystone Giant Strain Insulator which is porcelain covered for all weather service and backed by over 30 years of unfailing service you have a "hard-to-beat" combination. You can do a better, longer-lasting job with Keystone.

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OHIO "Extra Strength" MAGNETS
MOVE FERROUS METALS

FASTER!
SAFER!
CHEAPER!

Ohio "Extra Strength" Magnets enable you to handle iron and steel — in storage yards and out on the line — for a fraction of the cost of any other method. Special design features of Ohio Magnets keep them on the job longer — give you *efficiency plus!* While ordinary magnets often require welding of mounting ears due to wear from chain pins, Ohio "Extra Strength" Magnets prevent chafing by having mounting holes and chain pins cast square.

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CHESTER BLAND, PRESIDENT
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received his training in mechanical engineering at Texas Agricultural and Mechanical College. Before coming with Gulf he worked in the steam turbine service department of Westinghouse Electric Corporation, and later as assistant superintendent of power of Crucible Steel Company at Midland, Pennsylvania. He will make his headquarters in Pittsburgh, Pennsylvania.

H. A. GODDARD

Homer A. Goddard, lubrication engineer, has been appointed assistant division manager in charge of industrial lubricating sales for the Pittsburgh division of Gulf Oil Corporation, embracing Western Pennsylvania and West Virginia.

Mr. Goddard, who came with Gulf in 1932, has been serving as superintendent of industrial lubricating sales for this territory. A graduate of Colorado School of Mines in 1925, he was previously employed in underground coal mine engineering by Consolidation Coal Company and Pittsburgh Coal Company; and in engineering sales by Bethlehem Steel Company and Mine Safety Appliances Company.

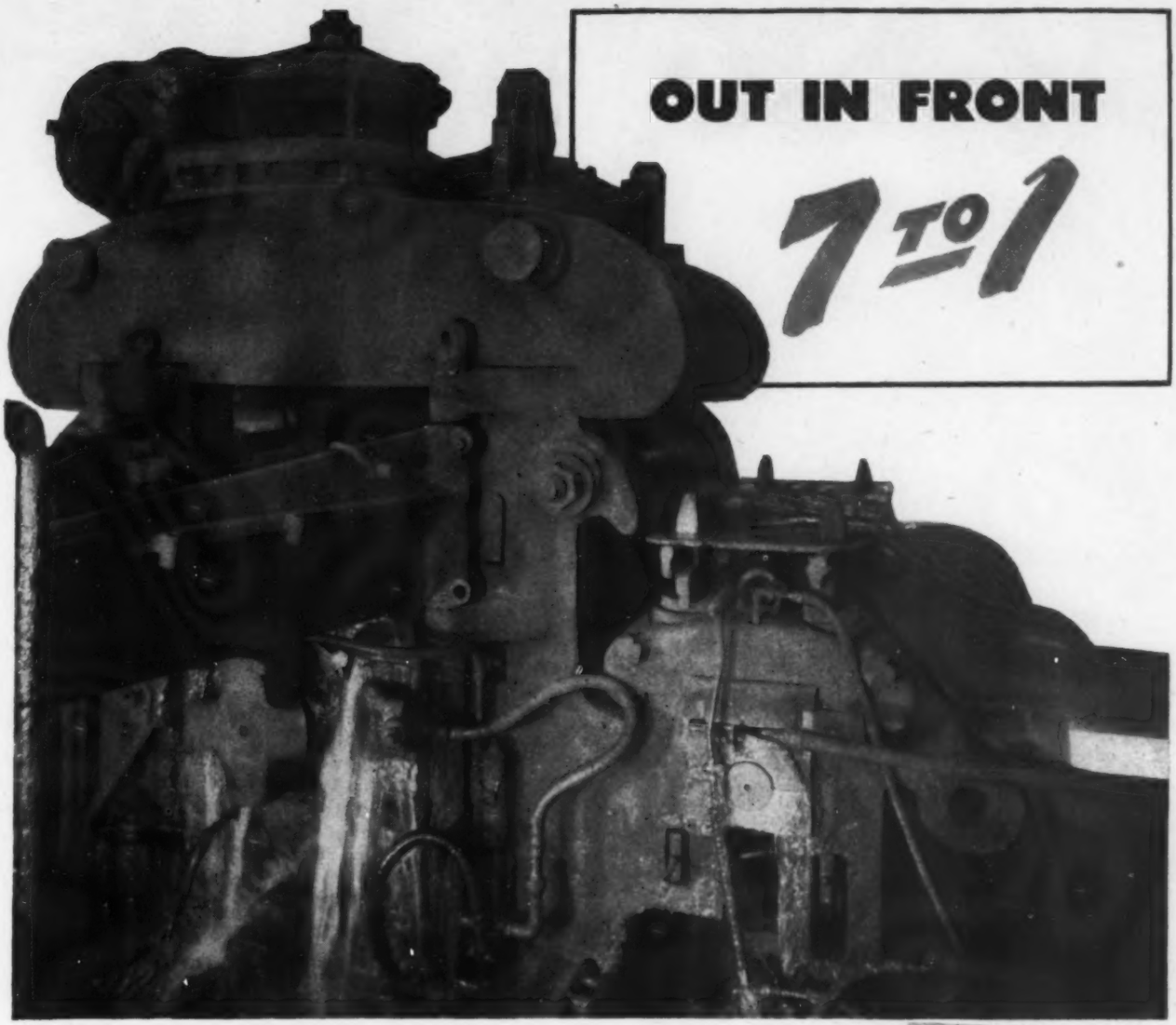
He succeeds **S. A. Newman,** who has been advanced to the position of chief turbine lubrication engineer in the general office.

Earl W. Mahaney, former metallurgist at the Brier Hill plant of the Youngstown Sheet and Tube Company has been moved to the main offices in Youngstown. He is associated with **Karl Fetters,** special metallurgical engineer, and works out of the office of **J. L. Mauthe,** vice president in charge of operations.

Mr. Mahaney joined the Youngstown Sheet and Tube Company in 1936 after his graduation from West Virginia University. He worked in the Campbell laboratory and plant before he was transferred to the Brier Hill plant.

John P. Roche has been named vice president and general manager of sales of Heppenstall Company, Pittsburgh, Pennsylvania. Mr. Roche comes to Heppenstall from Oliver Iron and Steel Corporation, Pittsburgh, Pennsylvania, where since 1944 he was secretary of the corporation as well as the assistant to the president.

A native of Pittsburgh, the new Heppenstall executive was graduated from Duquesne University. Mr. Roche joined the Oliver organization in 1939, following his graduation from the University of Pittsburgh Law School.



G-E TEXTOLITE ROLL-NECK BEARINGS WEAR SEVEN TIMES LONGER THAN METALLICS IN THIS MILL

The plug mill shown above rolls a 14-inch seamless tube and is located at the Aliquippe Works of the Jones & Laughlin Steel Corporation, Aliquippe, Pa.

G-E and J & L engineers worked together to develop the very satisfactory Textolite nonmetallic roll-neck bearings which are used in this mill—and their efforts are paying dividends.

Noticeable power savings have been recorded. These result from the low coefficient of friction which is characteristic of G-E Textolite bearings with water lubrication. Then, too, no longer is it necessary to contend with fire-cracked roll-necks. And most important of all, these G-E Textolite roll-neck bearings are wearing seven times longer than the metallics formerly used—saving on replacement costs and time-consuming shut-downs for bearing maintenance.

Our experienced bearing engineers are ready to help you with your particular bearing applications. They'll work with you to give your mills the many saving features which G-E Textolite roll-neck bearings have to offer. Write to Section U-6, General Electric Company, Plastics Divisions, Chemical Department, One Plastics Avenue, Pittsfield, Mass.

GENERAL ELECTRIC

CD46-C6

JONES AND LAUGHLIN

CASE HISTORY NO. 3

Save with **TEXTOLITE**

Maximum production • Long Life • Low-power consumption • Low grease bills • No fire-cracked roll-necks

YOU GET MORE

WITH LESS

WHEN YOU USE

NON-FLUID OIL

TRADE MARK REGISTERED

● You get more *lubrication* with less *lubricant* when you use NON-FLUID OIL because it *stays put* in vital working parts and does not spatter or run. Consequently it requires less frequent application. So much less, in fact, that production men everywhere agree it outlasts ordinary liquid oil 3 to 5 times!

Aside from its dripless and wasteless properties, NON-FLUID OIL is the perfect lubricant for all moving parts. There is a NON-FLUID OIL for every lubricating use. Write, wire or phone today for your descriptive bulletin and a testing sample of NON-FLUID OIL which will be sent by prepaid express.

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NEW YORK & NEW JERSEY LUBRICANT CO.
292 MADISON AVENUE, NEW YORK 17, N.Y.

R. L. Puette, a graduate of Case School of Applied Science, and for the past year general sales manager, has been made production manager for Clark Controller Company, Cleveland, Ohio. His many years contact with all types of heavy duty industry on electrical control problems give him a wide knowledge of the requirements in these fields.

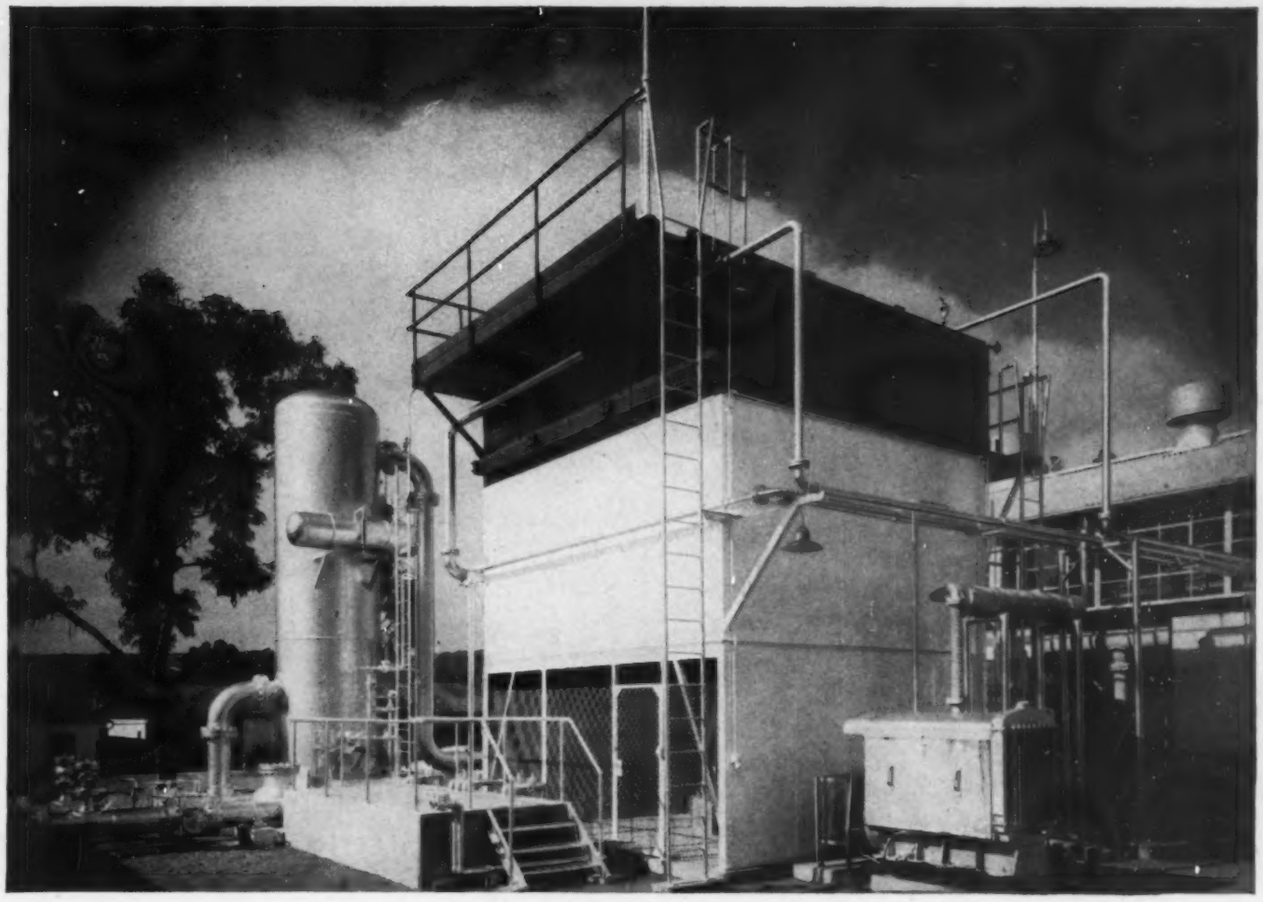
R. L. PUETTE

Don L. Orton, former assistant general sales manager, and previously manager of the Gary, Indiana, district office was appointed general sales manager for Clark Controller Company, Cleveland, Ohio. Very well known in the Gary-Chicago and other steel mill centers, Mr. Orton's broad experience and wide acquaintance in the heavy industries particularly fit him for his new work.

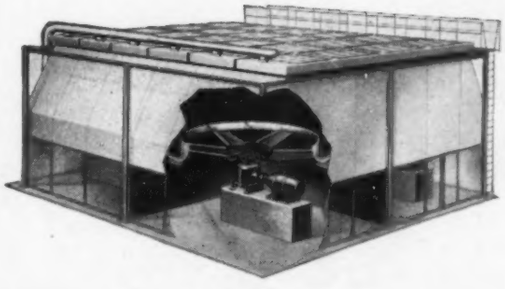
DON L. ORTON

O. J. Malina was appointed sales manager of the heating and ventilating division of the D. J. Murray Manufacturing Company, Wausau, Wisconsin. Mr. Malina's office is located at 43 East Ohio Street, Chicago, Illinois. He had been located in Chicago as mid-west representative of the company, prior to his appointment as sales manager.

J. V. Schrock, assistant to the general superintendent of the Pittsburgh works of the Jones and Laughlin Steel Corporation, has retired after 23 years' service and 51 years in the steel business. Mr. Schrock started



FIN·FAN MEETS RIGID BUILDING REGULATIONS AND RENDERS TRIPLE SERVICE



FLUOR FIN·FAN Cooling Unit consists of finned tubes over which air is circulated by variable pitch fans. ★ FIN·FAN Cooling Units are manufactured and sold by: The Griscom-Russell Co. and The Fluor Corporation, Ltd.

The versatility of the FLUOR FIN·FAN Cooling Unit is clearly demonstrated by the installation pictured above. This FIN·FAN Cooling Unit is installed in one of the compressor plants of a West Coast Natural Gas Company, adjoining a residential area.

Rigid building restrictions limited the height of the structure to 25 feet and prohibited any cooling water spray or condensation being permitted to pass over adjacent homes and buildings. In addition, the Gas Company required a unit which would perform a triple cooling job: 1. jacket water; 2. oil; 3. gas.

The FLUOR FIN·FAN Cooling Unit not only met all building requirements but it renders the triple service specified.

The FIN·FAN Cooling Unit operates efficiently on building tops or at ground level, and it can be applied to a wide range of condensing and cooling services. Investigate the FIN·FAN Unit—it may be the answer to your cooling problem. Write today for the Fluor General Catalog No. 46.

BE SURE SINCE 1890 WITH FLUOR

FLUOR FIN·FAN COOLING UNIT

THE FLUOR CORPORATION LTD., 2500 South Atlantic Boulevard, Los Angeles 22
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ENGINEERS • MANUFACTURERS • CONSTRUCTORS

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AIRE-RECTIFIER

A Pit Crane in the Plant of a Large Steel Company, with Lintern Aire-Rectifier.

Tried and Proved on

Soaking Pit Cranes

This is the only crane cab conditioner which has had thorough testing on soaking pit applications. It has operated successfully in a number of plants under the most severe conditions.

The Lintern Aire-Rectifier, *with air-cooled condenser,* is noted for its low maintenance — operating day after day, month in and month out with little or no maintenance. This is due to its *balanced refrigeration design* which prevents motor overloads in temperatures as high as 170° F. Only periodic inspection is required.

Models are available with or without filtering equipment for all phases of mill operation. This equipment is tried and proved — backed by extensive experience, designed and built by specialists in this field. Ask for Bulletin AC 42246.

THE LINTERN CORPORATION

54 LINCOLN AVENUE · · BEREA, OHIO

Aire-Rectifiers, Ventilating Heaters, Glowlites, Crane Safety Equipment, Safety Signals and Markers.

with Jones and Laughlin in 1923 in their Pittsburgh works accounting department. In 1929, he was made assistant to the general superintendent. Prior to coming to J&L, Mr. Schrock was associated with the Carnegie Steel Company for 28 years.

Dr. John Johnston retired as director of the Research Laboratory of United States Steel Corporation of Delaware. He will be succeeded by **Dr. J. B. Austin,** assistant director, who studied physical chemistry under Dr. Johnston at Yale University and has been associated with him at the laboratory since its inception. Dr. Johnston plans to live in Maine following his retirement.

Dr. Austin was born in Washington, D. C., July 16, 1904. He was graduated from Lehigh University in 1925 in chemical engineering and then studied physical chemistry under Dr. Johnston at Yale, being graduated with a Ph.D. in chemistry in 1928 and joining the staff of the Research Laboratory in the same year.

Bruce Bevelheimer has been named assistant to the vice president of Furnace Engineers, Inc., Pittsburgh, Pennsylvania, industrial furnace designers and builders, according to an announcement by the organization. Mr. Bevelheimer, a fuel engineer, has been associated with the steel industry since 1924 when he joined the technical staff of the Bethlehem Steel Company at the Sparrows Point, Maryland, plant. He has been associated with the Algoma Steel Corporation, Sault St. Marie, Ontario, since 1944. Mr. Bevelheimer is a member of the Association of Iron and Steel Engineers.

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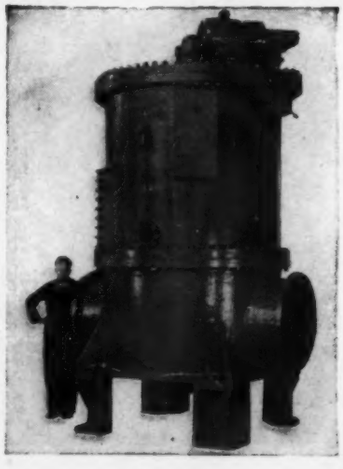

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is the installed capacity of the 400 strainers used throughout industry. Pipeline sizes 3″ to 30″. Write for descriptive circular.

S. P. KINNEY ENGINEERS

233 OLIVER AVENUE PITTSBURGH, PA.

NEWS SUPPLEMENT

(*Continued from page 130*)

CARBON-GRAPHITE GIVES BETTER BEARING SERVICE

▲ During the past decade, great improvements have been made in bearing materials, but many mill operators are still overlooking the savings in operating costs that can be effected by the use of these new materials.

This saving includes not only bearing costs, but increased production which can be gained through the elimination of down time for bearing changes, a reduction in the amount of scrap rolled by being able to hold product to section, the elimination of roll neck grease, when lubricated with water, etc.

Recognizing the need in steel mill applications for a wear-resistant, self-lubricating bearing, one that will require a minimum of attention, and will give maximum service, the Gor-Van Bearing Company has applied a material known as "Graphitar," a carbon-graphite substance, to mill bearings with outstanding results. The chemistry of the substance used in mill bearings is held closely to Gor-Van's exacting and particular specifications.

Graphitar is a material which lends itself readily to use as a bearing surface, having high compressive strength, 18,000 to 37,000 pounds per square inch, a high degree of resiliency, for example, a ball of the substance dropped upon a smooth concrete floor will rebound to a height of 70 per cent of that from which it is dropped.

The co-efficient of friction of the material ranges from .04 to .25, depending upon the grade and application. This is without the use of any lubricant.

It is resistant to heat, not oxidizing in temperatures up to 700 F, and will not melt or fuse at any temperature.

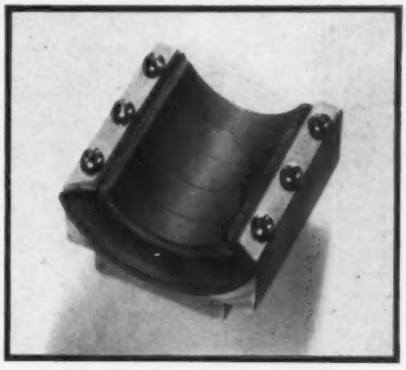
The material has an extremely low co-efficient of linear thermal expansion, and for a range of 75 F to 625 F is only .0000015 in. per in. per degree Fahrenheit. It also has a high thermal conductivity, or heat radiating capacity.

It is light, the range being .952 to 1.074 ounces per cu in., depending on the grade. The Scleroscope hardness ranges from 30 to 100, most grades being in excess of 75.

It is porous, most grades being able to absorb fluid up to 10 per cent by volume.

The material is made in many forms, but for the most economical application as a roll neck bearing, a ring is used. These rings are made in a number of sizes and can be adapted to any roll having a roll neck diameter of 12 inches or under. On roll necks exceeding 12 inches in diameter, other shapes are used.

The rings are molded under terrific pressure, and are then cured or baked in atmospheric controlled furnaces at temperatures up to 3000 F and are then precisely machined and finished. They are sent to bearing consumers in ring form. The rings are cut to the desired segment size, usually 120 degrees. The bearing chock bore must also be machined exactly so as to present a perfect mating surface, with the ring segment O.D. These segments are compressed into the chock, giving the bearing liner extreme strength and durability.



A carbon-graphite substance is applied to mill bearings with outstanding results.

Bearings for roll journals have been tested for the past two years and results are very gratifying to users, at the present time.

Roll neck bearings removed from mills show a high gloss finish and impart the same luster to the roll necks, impregnating them with particles of graphite.

Water is used as a lubricant on these roll neck bearings, although as explained above, the bearings will operate with no other lubricant than is self contained. The addition of water, however, reduces the co-efficient of friction to an even lower point, and gives greater operating economy.

These bearings have been used in mills with roll speeds ranging from 13.86 rpm with a reduction of 33.2 per cent of a 4¾ in. billet, to 66.52 rpm with a reduction of 26.4 per cent finishing an 1¾ in. billet. This application is on an 18 in. continuous mill, with rolls having a neck diameter of 12 in.

In a sixteen stand continuous rod mill with a 12 in., 6 stand rougher, roll neck diameters of 7½ in., and 10 in. 10 stand finisher, roll neck diameters of 6 inches, these bearings have given excellent results. This mill has a finishing speed of 1243 rpm, 3539 ft per min. In an inspection of bearings from this mill, after rolling 25,000 tons of stock, .060 in. wear was noted. Wear of .075 in. was checked in billet mill installation after 82,000 tons of stock had been rolled. These are typical applications as roll neck bearings.

Riders and carriers, as well as work bearings, are being used in these installations with the same marked improvement over previously used materials. These are installed in the same manner as the roll neck bearings, using the ring segment, the length of which varies from 90 to 100 degrees.

The use of these bearings is particularly advantageous on mills rolling stainless steel, or specialty grades, where the use of water is prohibited. Here their self-lubricating qualities make them outstanding, eliminating excessive bearing wear.

Graphitar bearings are extremely valuable on roll shafts used in continuous furnaces, or on roller lines used with open back billet heating furnaces. Here their high heat resisting qualities place them far above the usual type of bearings used in similar applications.

They are also adaptable to use as wheel journal bearings on annealing cars. Here again, their heat resisting value stands them in good stead.

For these latter applications, specially machined shapes are used, and it is possible on the smaller shaft diameters to make sleeve bearings in one piece, up to 12 in. in length. This reduces cost and facilitates installation.

——11-E-8——

Constructioneering

by F. Mohler

PATTERSON - EMERSON - COMSTOCK, INC.
PITTSBURGH, PENNSYLVANIA

▲ There is always something new, even this coined title, "Constructioneering," which is, of course, a combination of the words "Construction" and "Engineering."

Anyone having followed application engineering and construction work for the past twenty years, must have developed a very definite feeling that there was a real need in the steel industry for an organization that paid equal attention to both engineering and construction, in connection with the installation of steel mill equipment. This is especially true under present conditions and those which will probably prevail for a good many years to come.

Let us examine some of the fundamentals of this phase of industry. First of all, speeds of operation are rapidly increasing, automatic control of processes is steadily taking the place of manual operation, and more complete mechanization is being used to eliminate handling. This means the ever increasing complexity of electrical and mechanical equipment, and a greater and greater capital investment. Thus, more and more, application engineering is required in a given project, and once the money is appropriated, it is essential to get the equipment operating at its maximum efficiency just as quickly as possible.

In the second place, equipment may be let to a number of manufacturers, and there is a tremendous job of coordinating engineering to be done if the equipment is to go together and operate as a unified process.

In the third place, the smaller steel companies cannot afford, and the larger companies find it extremely difficult, to build up an adequate engineering and construction force just to man a given project.

In the fourth place, in many cases the individual suppliers of equipment do not have the proper staff either to do the overall application engineering; coordinating engineering; make the mechanical, electrical, excavation, foundation and piping installation drawings; or to do the installation and erection work.

In the fifth place, the war has created a terrific lack of designing engineers, and it is almost invariably necessary to proceed with installation drawings based on pencil sketches and conferences with the various manufacturers. When working under such handicaps, it becomes even more apparent that if a coordinated job is to be obtained, all installation drawings should be made by one organization under one central supervision.

F. MOHLER

In the sixth place, in order to obtain the best efficiency from labor from the various skilled crafts, to eliminate work interferences, and, in general, to make for a smooth running, coordinated erection job, all phases of the erection should be under a common supervisory staff.

In the seventh place, because of incomplete information, scarcity of various construction materials with the resulting substitutions, and the absolute necessity for the proper flow of installation drawings and material to the job to keep the erection progressing smoothly, both installation drawings and erection should be under a common head.

Let us now examine some of the various phases of engineering and construction. Application engineering has to do with the overall understanding of various processes, the equipment required to produce the desired results, its required operation, proper location, and the problems involved in production and maintenance. An understanding of application engineering is essential, therefore, to assist the purchaser in buying the proper equipment, in arranging it so as to obtain the best results, and in making the necessary installation drawings.

Coordination engineering has to do with the assembly of information in the form of sketches, outlines, wiring diagrams, and all the myriad details from the various manufacturers and the purchaser, so that intelligent installation drawings can be made, and the proper flow of drawings and material to the field can be maintained.

Design engineering has to do with the actual making of installation drawings, involving the design and layout of the proper excavations, forms and foundations for the mechanical and electrical equipment; the design, layout, and selection of types and sizes of pipe, valves and fittings for water, air, steam, gas, acids, lubrication, etc.; the design, layout, and selection of wire, cable, conduit, bus, insulators, ventilating ducts, motor rooms, control houses, operating pulpits, etc., for the electrical equipment; and the layout arrangement of foundation bolts, operating platforms, flues, pits, etc. for the mechanical equipment.

Construction engineering has to do with the actual erection work in the field, and involves the supervision of the various construction crafts to see that the installation drawings are properly followed, that a workmanlike job is obtained, and that the work progresses expeditiously.

Field engineering has to do with the checking of the equipment after its installation, and with placing it in operation and actual production.

The proper blending of these various engineering services with good overall construction work must provide a speedier, more efficient and less costly installation. In other words, constructioneering will pay dividends to the steel industry.

—11-E-9—

NEW SPRAY-TYPE MACHINE FOR CONTINUOUS PICKLING

▲ A new spray-type machine for continuous pickling and washing of any metal part requiring surface preparation for the application of coatings or for the removal of scale is announced by the industrial products sales division of the B. F. Goodrich Company.

Pieces are fed onto a conveyor at the entrance to the machine and carried through the spraying and washing cycles, emerging acid free and ready for the succeeding operations.

Each unit is designed individually to suit the particular manufacturing problem and is lined with rubber by the company's famous "Vulcalock" process of adhering rubber to metal. The machine has been used successfully for pickling cartridge cases and preparing steel hollow-ware for enameling.

Advantages cited by the company for the machine over the dip method widely used are:

Straight line operation is obtained, with materials requiring minimum handling, being fed into the conveyor feeding into the machine and carried automatically through each pickling and washing operation without intermediate handling.

Production can be standardized, no special equipment being required for handling pieces of different shapes and sizes, the conveyor carrying any size or shape within the over-all size limits of the unit; no special racks are required for handling.

The spray principle is most efficient. Hard-hitting, under pressure, it removes scale and foreign material faster and more thoroughly. Hollow-ware articles, which tend to float or develop pockets in a dip system, are cleaned completely by the spray process.

In one operation, time for pickling is reduced to four minutes from the 15 minutes it required in the old-type dip process.

Flexibility of operation is possible, as the unit can be designed to fit almost any requirements, with different sizes and varying numbers of compartments for washing and pickling solutions.

Durability of the machine is assured by the strength of construction on prepared foundations, so the completed plant will withstand shocks and hard usage. Acid-resisting rubber compounds, applied by the B. F. Goodrich Vulcalock process are used to line the all-welded steel tank spray compartments, conveyor rolls and pipes and fittings, assuring longer trouble-free service, reduced maintenance and longer life.

—11-E-10—

ADJUSTABLE WEIGHBEAM REPLACES STANDARD TYPE

▲ Pneumatic pressure and differential pressure transmitters can now be furnished with an adjustable weighbeam — a new development by Republic Flow Meters Company which makes possible a 15 to 1 range change without change of parts. The only readjustment necessary is rebalancing for zero.

This feature is provided by replacing the standard weighbeam by a double weighbeam having an adjustable pivot between the two halves. The range of the transmitter is changed by merely sliding the adjustable pivot along a calibrated scale to the desired setting. For example: a differential transmitter having a minimum range of from 0 to 1.0 in. of water can be changed to any range up to 0 to 15.0 in.; similarly a transmitter with a minimum range of 0 to 8.0 in. can be changed to any range up to 0 to 120.0 in.

The flexibility of application provided by this new development is of paramount importance on those installations where operating conditions are highly variable or on new installations where flow or pressure conditions are unknown.

—11-E-11—

DEVELOP ELECTRO-MAGNET WITH SPECIAL ALLOY TIPS

▲ An electro-magnet so powerful that the operator must stay at the controls four yards away when it is at peak operation in order to avoid having his pockets picked has been developed by Dr. J. E. Goldman of the Westinghouse Research Laboratories. It is an oil-cooled, one and one-half ton, iron core, electro-magnet wound with 6000 turns of square copper wired and tipped with a special magnetic alloy.

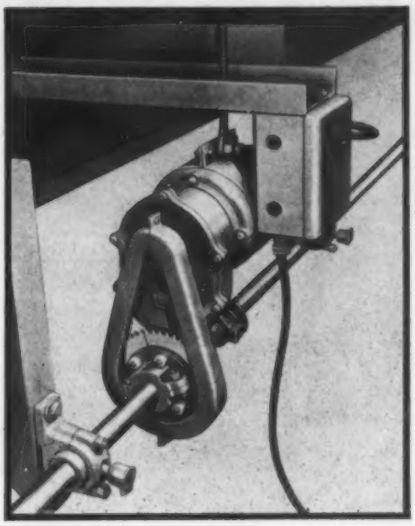
The magnet, five feet long and two and one-half feet high, has adjustable poles so that specimens from 1½ to 12 inches may be attracted and is capable of exerting a concentrated 4000 pound pull, a force strong enough to make possible new studies in magnetism.

One secret of the high magnetism produced is the special alloy tips. This alloy was developed by the Westinghouse Research Laboratories to give more magnetic energy than ordinary iron.

The variation in the gap between poles is accomplished by the use of adjustable tapered pole pieces. This feature adds immensely to the versatility of the magnet.

The new magnet can be used as an aid to the design of cyclotrons, for the production of small permanent magnets that will make possible smaller and lighter aircraft instruments, and as a fundamental research tool for the study of the relationship between the crystal structure of metals and their magnetic properties. —11-E-12—

ELECTRIC POWER TRAVEL APPLICABLE TO ANY CRANE



Shown above is the "Travelator", which provided electric power travel for and traveled overhead cranes, is now available in a universal mounting which makes it applicable to any type overhead crane, both single and double girder. Nearly every arrangement of beam and hoist to be found in hand traveled cranes can be handled with this new universal mounting.

The motor is held in a steel mounting band which is connected to the mounting bracket. This mounting band may be given any position about the periphery of the motor. Manufacturer is the Northern Engineering Works. —11-E-13—

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Dominion Foundries & Steel, Ltd.
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New York, New York

Accurate Measure And Control of Fuel Oil And Viscous Liquids

One of the most vital — and yet most difficult — things in the whole field of combustion is the accurate measurement and control of heavy fuel oil.

A new unit called the "Transometer" now makes possible control, integrating, remote indication and recording, of this hard to handle fuel.

A combination of a piston type, positive displacement meter and a pneumatic signal transmitter, the Transometer is equally valuable with other liquids — particularly viscous fluids because its accuracy is unaffected by viscosity changes.

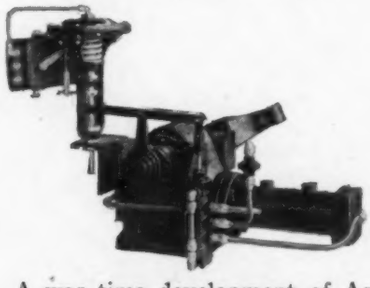
Having so much power, even at the lowest flows, it is ideal for applications where wide flow variations are encountered.

Full information may be secured from Askania Regulator Company, 1603 S. Michigan Avenue, Chicago, Ill.

Ask for Bulletin 125

★ ★

High Power Hydraulic Amplifier For Air Operated Controls



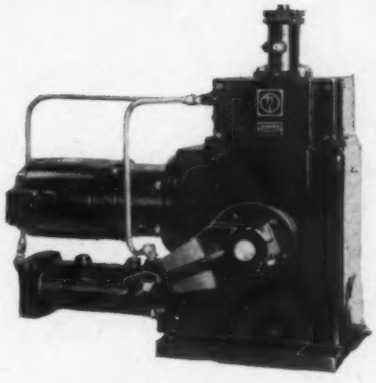
A war time development of Askania Regulator Company, 1603 South Michigan Avenue, Chicago, Illinois, is an oil operated hydraulic booster cylinder for air operated controllers. Using a standard diaphragm top it provides high power amplification and permits exact positioning of heavy dampers, valves and the like in accordance with the applied pneumatic loading pressure — usually 0-15 pounds p.s.i.

The cylinder may be of the crank type, as shown, or of the straight reciprocating type. Straight cylinders are available up to 8" bore and 30" stroke.

Other types of remote positioning cylinders are available using electric instead of pneumatic transmission.

★ ★

Complete Package Automatic Control In Single Unit



Can be applied to flow pressure on Ratio Control

The Askania Regulator Company's Power Unit is a hydraulic crank type cylinder, whose operation can be controlled by most any type of air operated controller. The cylinder produces a crank arm stroke directly proportional to the loading pressure developed by the air operated controller. A change in loading pressure of one ounce and a bellows movement of only .0066 inches will start the crank arm in motion. Thus it can be operated from the primary relay of any air controller.

The unit is self contained, easily installed and prevents maintenance problems. Power units are available from stock, have an accuracy of crank arm positioning of plus or minus ½ degree. Heavy loads can be handled with ease and accuracy . . . .as the Power Unit is designed for heavy duty . . . with a stalling torque of 4000 inch pounds.

Askania Remote Position Servo System

The Askania Position Servo System consists of transmitter, electronic control amplifier, and receiver. Its purpose is to position accurately a remote load under the control of the transmitter.

Transmitter

The transmitter shaft may be positioned by hand, or may be connected to any equipment whose angular position is to be transmitted. The torque required to operate the transmitter is negligible.

Control Amplifier

Indicator lights on the amplifier panel show if energy is supplied to the receiver, and in which direction.

A signal system indicates at all times whether or not a pre-determined unbalance between transmitter and receiver is exceeded.

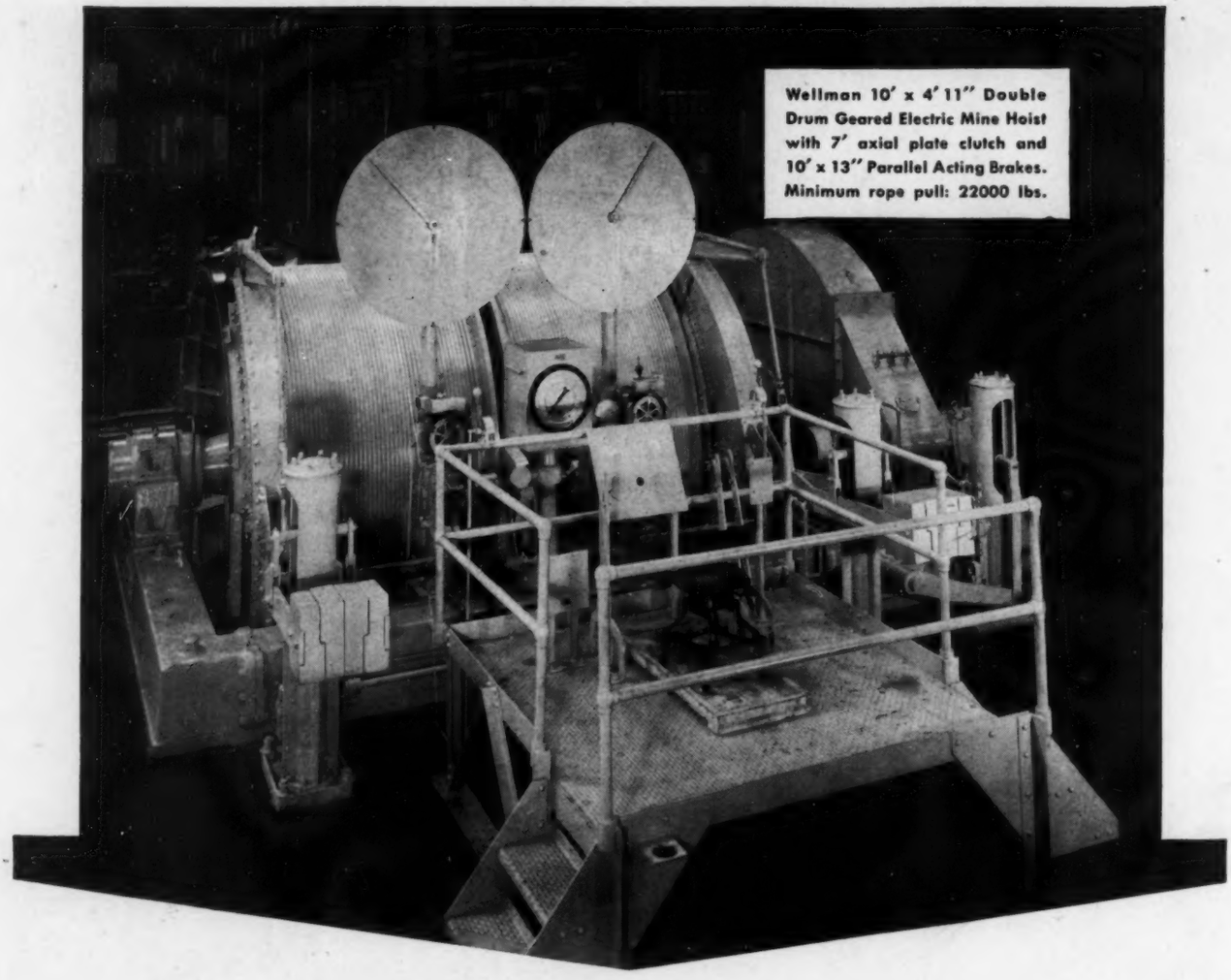
The amplifier panel may contain an "auxiliary transmitter" for manual positioning of the receiver.

Receiver

The receiver motor may be a small induction motor (no brushes or contacts) or, for heavy loads, an hydraulic motor capable of furnishing almost unlimited torque output. Accuracy of receiver position: ±0.1%.

Examples of Applications

Control of Bessemer converters from operator's pulpit; remote control of fuel to air ratio; remote setting of pressure regulators for open hearth furnaces.


Wellman 10' x 4' 11" Double Drum Geared Electric Mine Hoist with 7' axial plate clutch and 10' x 13" Parallel Acting Brakes. Minimum rope pull: 22000 lbs.

WELLMAN ELECTRIC MINE HOISTS

Designed by Specialists • Built by Specialists

INSURE PEAK EFFICIENCY

Wellman Electric Mine Hoists are used in mines all over the world. Backed by half a century of diversified experience, they incorporate the best and latest principles of design and construction and provide maximum safety with economical, trouble-free operation.

Wellman hoists have been built in a wide range of sizes to operate under a wide variety of conditions. Ask us for recommendations on your job!

THE WELLMAN ENGINEERING COMPANY

7031 Central Avenue • • Cleveland 4, Ohio

ROLL OFF NEW PRODUCTION RECORDS WITH N·B·M #200 BRONZE BEARINGS

Think how you could increase your tonnage if your roll neck bearings would last 10 to 18 times longer between replacements!

That's just what N-B-M #200 Bronze Bearings are doing for mill after mill. Besides, they assure more uniform gauge—freedom from cut roll necks—big savings in power and maintenance costs. Our engineers will gladly show you how.

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BRONZE AND COPPER CASTINGS

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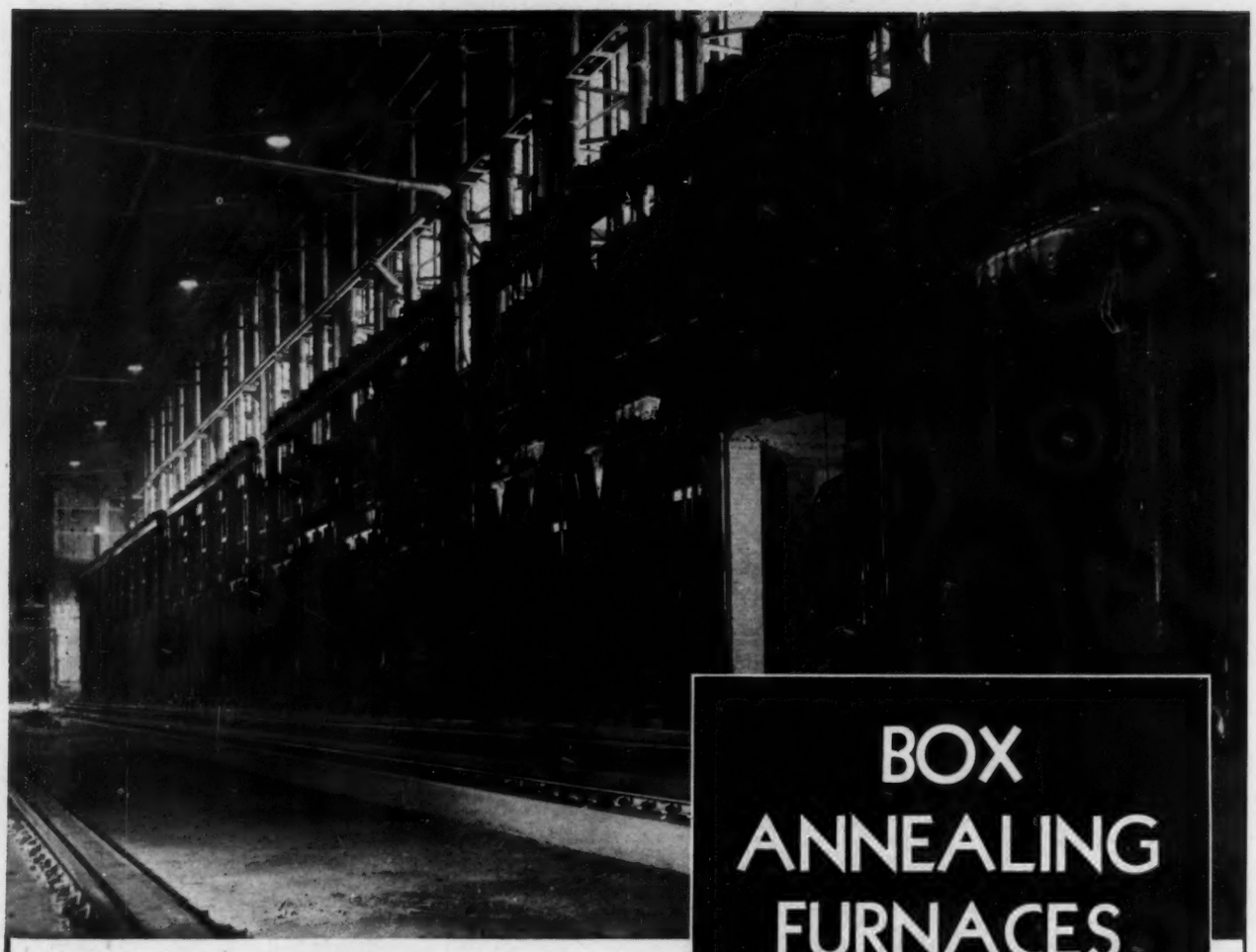


BOX ANNEALING FURNACES

Tailor-Made Furnaces

Sound Design, Rugged Construction, Superior Performance

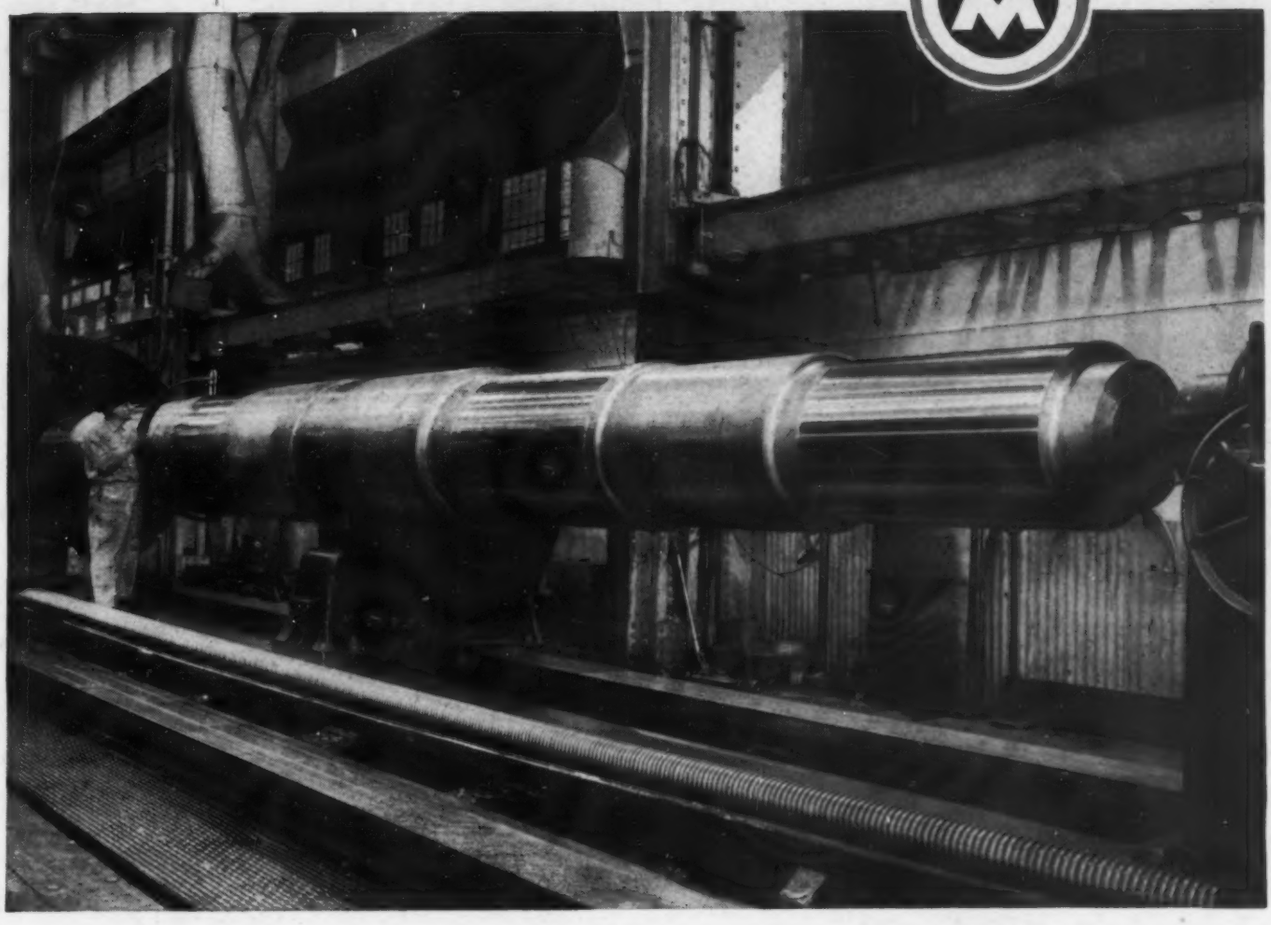
This type of Box Annealers, designed and constructed by Loftus, assures faster heating and highest efficiency in direct-fired annealing furnaces.

Fuel costs and maintenance expense are held to a minimum, the handling of the work is simplified, and congestion in the annealing department is avoided.

Your inquiry is invited and will be carefully considered.

610 SMITHFIELD ST. **LOFTUS ENGINEERING** *corporation* PITTSBURGH, PA.

Designers and Builders — Engineers, Consultants, Contractors



MORE THAN MEETS THE EYE . . .

This great, forged mine hoist shaft embodies extreme accuracy in every detail. Built perfectly to meet specifications demanding ability to withstand hundreds of tons of weight, this forging, like all Midvale forgings, passed through our quality control system. This, in effect, guarantees in melting, forging, heat treating and measurement an accuracy that has become the characteristic of Midvale manufacture.

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Custom Steel Makers to Industry

STAINLESS AND TOOL STEEL BARS

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CORROSION AND HEAT RESISTING CASTINGS

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FORGINGS AND RINGS

Let's clean house now— start scrap moving—

FABRICATORS NEED STEEL

STEEL MILLS NEED SCRAP

Here's what you can do to help get much-needed scrap to Steel Mills.

1 ***Check Your Plant and Property*** and appoint someone to earmark every piece of machinery and equipment that can be cut up for scrap.

2 ***Consult Your Local Scrap Dealer*** to learn what size scrap brings highest returns—then flame-cut to size all obsolete machines, structural shapes, pipe, old boilers, and other large pieces.

3 ***Classify and Segregate*** alloy steels and other special materials to be sure they are used to best advantage and to obtain higher prices.

4 ***Move Scrap Fast*** when it is ready. Sell it, ship it—keep it moving.

Linde can help you work out a practicable scrapping program—just call our nearest office.

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To help you identify the common metals for proper scrap classification, we will be glad to send you, without charge, as many copies as you need of the wall charts "Identifying Metals by Spark Testing" (ask for form 4666) or "Simple Tests for Identifying Metals" (ask for form 2299).

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It takes all seven..

to permit you to select the Insulating Fire Brick with the correct *balance* of thermal and physical properties for each service in your plant.

PROPERTIES	INSULATING BRICK			INSULATING FIRE BRICK AND FIREBLOK			
	Sil-O-Cel Natural	Sil-O-Cel C-22	Sil-O-Cel Super	JM-1620	JM-20	JM-23	JM-26
Density—lb. per cu. ft.	30	38	40	29	35	42	48
Transverse Strength—lb. per sq. in.	140	115	90	60	80	120	125
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	115	170	190
Linear Shrinkage—Percent	1.4 @ 1600F	0.8 @ 2000F	2.0 @ 2500F	0.0 @ 2000F	0.0 @ 2000F	0.3 @ 2300F	1.0 @ 2600F
Reversible Thermal Expansion—Percent	0.1 @ 1600F	0.7 @ 2000F	1.3 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F
Conductivity at Mean Temperature	∥ ⊥						
500F	1.01 .67	1.67	1.70	.77	.97	1.51	1.92
1000F	1.13 .79	1.88	1.95	1.02	1.22	1.91	2.22
1500F	1.24 .90	2.08	2.19	1.27	1.47	2.31	2.52
2000F	— —	—	2.45	—	1.72	2.70	2.82
Recommended Service							
Back Up	1600F	2000F	2500F	2000F	2000F	2300F	2600F
Exposed	—	—	—	1600F	2000F	2300F	2600F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note: 1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu in. per hr per sq ft per deg F at the designated mean temperatures.
3. ∥ —with heat flow parallel to brick strata.
⊥ —with heat flow perpendicular to brick strata.

No one brick can perform properly under all steel mill service conditions. That's why Johns-Manville makes seven types of Insulating Brick and Insulating Fire Brick. Each is designed for a specific job . . . and *engineered* to do its job with maximum efficiency.

The three J-M Insulating Brick provide great structural strength; the four J-M Insulating Fire Brick combine strength with exceptional resistance to spalling. All offer the advantages of light weight and low conductivity. They are recommended as back-up insulation or insulating fire brick for all industrial requirements.

For complete details, write Johns-Manville, Box 290, New York 16, N.Y.

JOHNS-MANVILLE *First in* INSULATIONS

Farval could have saved this $800 bearing expense

A MID-WEST manufacturer installed forty-one new overhead traveling cranes. All were roller-bearing equipped. Some cranes came from the builder equipped with Farval; others had to be lubricated by hand.

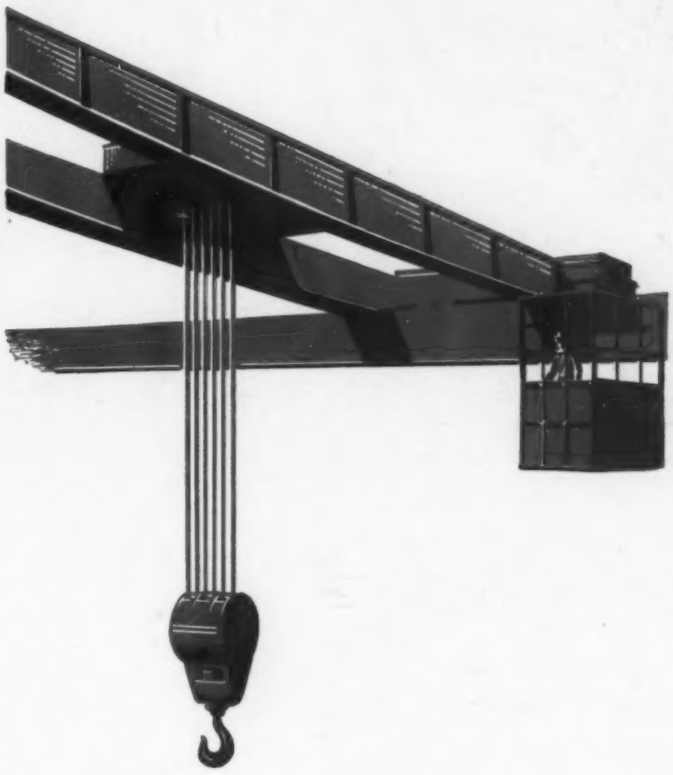
Within six months, the value of Farval was clearly demonstrated. The cranes without centralized lubrication became involved in delays and replacements of bearings. On two 30-ton cranes, bearing replacements alone amounted to over $800. On the Farval-equipped cranes, all bearings were lubricated from a safe central point and delays and expense for repairs and maintenance were unknown.

An overhead crane shutdown can be as serious as a stoppage of any floor-level machinery. Centralized lubrication, therefore, is even more essential on the isolated overhead equipment, which cannot be inspected from the floor and where you may risk serious injury to lubricate the hard-to-get-at bearings.

With Farval every bearing receives oil or grease from a safe central station, in exact quantities, at regular intervals—sure protection between mechanical inspections. Farval—the Dualine System with the Positive Piston Displacement Valve—that has but 2 Moving Parts —is Fully Adjustable—and with a Tell-tale indicator at each bearing to show the job is done.

Protect your old cranes by installing Farval. Provide safety, lower maintenance and eliminate delays—ask for Farval on your new cranes. Write for Bulletin 25. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited



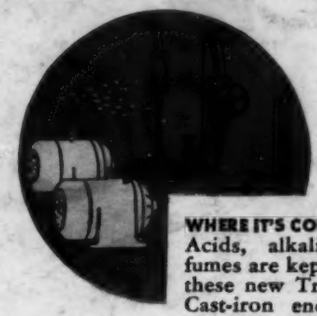
FARVAL—Studies in Centralized Lubrication No. 80

FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION

FOR TODAY'S **TOUGHER JOBS,** HERE'S A NEW **TOUGHER MOTOR**

WHERE IT'S WET Wet weather doesn't bother the new totally-enclosed Tri-Clad motor. Neither do frequent "washdowns" in food plants.



WHERE IT'S CORROSIVE Acids, alkalis, and fumes are kept out of these new Tri-Clads. Cast-iron enclosures are corrosion-resistant, extra strong.

WHERE IT'S DIRTY Dirt and dust can't get into these Tri-Clads to shorten their life. Smooth surfaces are convenient to clean.

WHERE IRON DUST FLIES Harmful iron dust and metal filings can't get past the inner wall. Bearings are protected from dust.

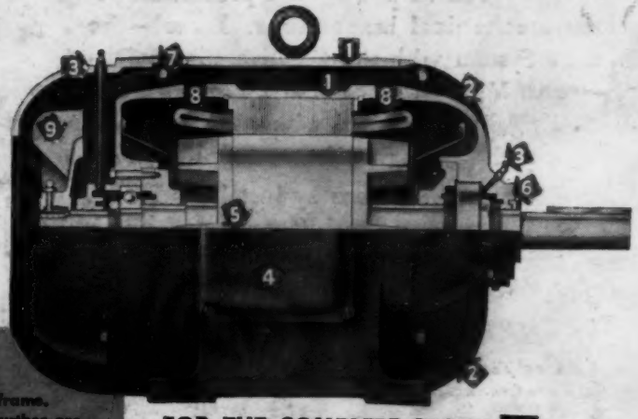
WHERE QUARTERS ARE CLOSE When space is limited for a totally enclosed motor, you'll like these trim, compact new Tri-Clads.

WHERE EXPLOSION HAZARDS EXIST The new Tri-Clad motors are available in explosion-proof constructions where needed.

THE G-E *TRI-CLAD* TOTALLY ENCLOSED MOTOR

(1 TO 1000 HP)

In 1940 you welcomed the Tri-Clad open motor with it's *extra protection features*. More Tri-Clads have since gone into service than any other integral-horsepower motor. Now G.E. is ready with a new line of tough, totally enclosed Tri-Clad motors for use in adverse atmospheres. *We believe they are industry's most dependable motors.* Their longer life and lower maintenance will make them a sound investment on almost every job. Apparatus Dept., General Electric Co., Schenectady 5, N. Y.



10-POINT PROTECTION

1. A cast-iron, double-wall frame completely encloses and protects the windings and punchings.
2. Corrosion-resistant cast-iron end shields are machined to provide a tight seal, and protect the motor from dust, dirt, and moisture. Primer and finish coat of Glyptal* varnish affords high rust-resistance.
3. A pressure-relief greasing system, which can be packed with long-life lubricant, protects the bearings.
4. The cast-iron conduit box is diagonally split for easy wiring. Boxes are independently explosion-proof on Class I motors.
5. Nonshrinking compound around motor leads protects motor interiors from dust and moisture at the point where leads pass through the frame.
6. Rotating labyrinth seal further protects motor interior from damage by foreign matter.
7. Large air passages provide adequate protection from overheating. They're easy to keep clean and open, too.
8. Modern, "ageless" insulation treatment includes windings of *Formex magnet wire.
9. The powerful external fan is removable to simplify maintenance; nonsparking type in explosion-proof motors.
10. Individual dynamic balance of rotors and external fans protects against vibration hazards, even under severe operating conditions.

*Trade-mark Reg. U. S. Pat. Off.

FOR THE COMPLETE STORY

Apparatus Department, Section E750-279C
General Electric Company
Schenectady 5, N. Y.

☐ Please send me GEA-4400, which describes the new Tri-Clad totally enclosed motors.

☐ Please send me GEA-4131, "Motors and Control for Hazardous Locations."

NAME _____

COMPANY _____

ADDRESS _____

GENERAL ELECTRIC